A QUARTERLY JOURNAL OF METHODS AND INFORMATION FOR TEACHERS OF SCIENCE

# The SCIENCE COUNSELOR



Volume XXII ★ Number 3 ★ Sept. 1959

"FOR BETTER SCIENCE TEACHING"

# The Science Counselor

*"FOR BETTER SCIENCE TEACHING"*

A QUARTERLY JOURNAL *of teaching methods and scientific information for teachers of science. Indexed in the Catholic Periodical Index. Published at Duquesne University, Pittsburgh, Pennsylvania, in March, June, September and December by the Science Departments of*

DUQUESNE UNIVERSITY

Subscription Price: $3.00 per year; Canada, $3.25. Single copies of issues in the current year, 75¢ each.
Business and Editorial Offices at Duquesne University, 901 Vickroy Street, Pittsburgh 19, Pa.



Volume XXII September, 1959 No. 3

CONTENTS



## *In Future Numbers . . .*

Among articles planned for publication in the near future are:

**Electronic Brains**
By A. W. Duerig, Plant Extension Engineer, Bell Telephone Company, Philadelphia.

**Scientific Careers for Catholic Students**
By Daniel M. Lilly, Biology Department, St. John's University, Jamaica, N. Y.

**Emphasizing the Process as Well as the Product of Science**
By John H. Woodburn, The Johns Hopkins University, Baltimore, Maryland.

**Teleology and Science**
By Rev. Charles J. Schaeflein, Roman Catholic High School, Philadelphia, Pennsylvania.

**Tomorrow's Scientist and the Liberal Arts College**
By Dale C. Braungart, Catholic University of America, Washington, D. C.

**Problems in Photosynthesis**
By Robert B. Gordon, Pennsylvania State Teacher's College, West Chester, Pennsylvania.

**Mathematics and Poetry**
By Charlotte Melcher, Marygrove College, Detroit, Michigan.

**Casey Colloid and His Characteristics**
By Sister Mary Michael Ann, P.B.V.M., Presentation Junior College, Aberdeen, South Dakota.

# Science and Wisdom

• By Edward Hennessy, C.P.
DIRECTOR, SAINT MICHAEL'S HIGH SCHOOL, PITTSBURGH 3, PENNSYLVANIA

*This article should be studied, not read.*

*It is taken from an address presented to the Pittsburgh Diocesan Science and Mathematics Teachers' Association, Duquesne University, February 7, 1959.*

●

You have honored me by asking that I break bread with you today and in turn share with you some thoughts touching upon your convention theme. I must protest at once that your invitation caused me dismay, for the natural sciences are not in my field of training. If at the end of this essay you have reached a similar conclusion, you will know that the kind insistence of your chairman appealed to my sense of chivalry and hunger put prudence to flight.

The difficulty lies in the title chosen for these remarks: "Science and Wisdom." My few excursions made into the field of the natural sciences have been compelled by a curiosity not easily controlled, or by the duty of walking down a pathway along which someone was feebly searching for truth.

Thus a graduate student in Physics, calmly dismissing the logic of Aristotelian and Thomistic Philosophy with a reference to logical analysis, forced me to an enlightening search into Mathematics. Another, rejecting the ontological proofs for the existence of God on the basis of mechanistic science, impelled me to seek to understand why he could so speak. A major in Bio-Chemistry mouthing Bertrand Russell led me to taste the ashes of his thought.

Paraphrasing and reversing the thought of Gilson that "no real master will ever invite us to listen to himself, but to the truth of what he says, such as we ourselves can see it in our minds." (Gilson: *History of Philosophy in the Middle Ages*, p. 545.) I may say to you that one who is no real master invites your attention only to the *truth of* what he says.

As our point of departure, we need to define our terms and the postulates upon which we begin. By "Science," I refer to the natural sciences and to those areas of mathematics which may claim a somewhat more theoretical, nonempirical character. In this connection we agree that there is an obligation resting upon our secondary schools to provide a sound yearly training in the natural sciences for all students, an obligation made urgent by the national need. We may add that a consistent program is directed to the development of an understanding of basic scientific principles in *all* students, with ultimate provision for advanced work for the more gifted child, but also with a positive plan for the continued growth of the non-academic student in this field. Finally, we agree that, having outlined such a field of emphasis, we must keep it within the context of the purpose of all true education on every level, to assist the development of the entire person in the likeness of Christ.

As we think of the world into which we send our graduates we must ask if this is enough. Have we done well by our senior if we have trained him to desire the vocation of the scholar in an abstract way, without some clear understanding of why he should do so? Can we pack him off to our universities bent upon learning but with no tool of decision as to that which is true, and that which is greatly commingled with error? How may we guard against the too easy ambition to use scholarship for merely material and personal gain? How save him from the dichotomy of a growth of the mind in the area of the scientific knowledge of his choice with no commensurate development in his role as a follower of Christ?

I believe that our last gift, yes our first and our last gift to the graduate of our schools is to have imparted to him, rather let me say, to have shared with him a deep love of wisdom. And for the moment, I prescind from that wisdom which is born of theology and grace and is the highest perfection of Faith and Love,—surely this is to be desired beyond all else and not by the scholar alone but by every child of God. Yet in this context I beg leave to speak of wisdom in the sense sacred to the philosopher as the science of knowing all things in their highest causes and of unifying all knowledge and science according to its mode of knowing. Wisdom thus envisioned is an end sought above and beyond the contributions of the lesser sciences to the formation of a scholar in his vocation. It is, as Newman said, "the calm, clear, accurate vision and comprehension of the whole course, the whole work of God." Dissatisfied with immediate truth, it presses on toward the final explanation, the ultimate principle. From this high point, wisdom relates one truth to another, one science to another and gathers all under the light of the last reason and meaning of all that is.

What role will the love of wisdom play in the developing life of our young scholar as diploma in hand he leaves us to seek knowledge in our universities? He will walk first with a deep sense of his calling for he is the child of the centuries, the heir of a wisdom which has created a civilization of glory. He will know that he is the follower of great scholars of the present who serve the cause of truth and mankind along the paths to the stern outposts of human knowledge be their eyes fixed upon the outer rim of Father Le Maitre's "expanding space" to whom Eddington and Milne acknowledged their debt; or searching the abyss of the atom.

After them our fledgling walks, ignorant of so much yet entrusted with so much. No field of knowledge is alien to his home, yet many no longer call his mother

by name. His vocation is to go to them, to master them and to bring them home.

"Rarely in the course of history has the position of Catholic students and intellectuals been so heavy with responsibility as it is today . . . Yes, be there at every point in the intellectual conflict, at this time when the problems of men and nature are being envisaged in the new settings and scope that will be theirs henceforward." (Pius XII: *Pax Romana*, 1950.)

The task will not be easy. The imperative of his vocation is to use every power to master his chosen field of scientific knowledge—without that he will be but another technician of method. An eminent master, (who exemplifies in his person all that we will say here), Etienne Gilson has said it in these words:

"If one wants to practice science for God's sake, the first condition is to practice it for its own sake, or as if for its own sake, because that is the only way to learn it . . . It is the same with art, one must learn it before one can put it to God's service. We are told that faith built the medieval cathedrals: no doubt, but faith would not have built anything had there been no architects and craftsmen. If it be true that the west front of Notre Dame is a raising of the soul to God, that does not prevent it from being a geometrical composition as well: to build well a front that is an act of charity, one must first understand geometry.

We Catholics, who claim the high worth of nature because it is God's work should show our respect for it by asking as our first rule of action that piety is never a substitute for technique: for technique is that without which the most fervent piety is powerless to make use of nature for God's sake.

Nothing and nobody obliges a Catholic to occupy himself with science, art or philosophy, but if he has chosen this way of serving Him, the end he puts before himself obliges him to excel; the very intention that guides him compels him to be a good scholar, a good philosopher, a good artist; it is the only way he can become a good servant." (Gilson: *Christianisme et Philosophie*.)

The pathway to mastery is lonely and hard. But lonelier still and harder yet is the way of the seeker after wisdom. Our students will know that we are living in the age of science and are destined to do so for the foreseeable future. It is an age when man has found it within the power of his mind and technique to assault the final secrets of nature and bend elemental powers to his will. The nation itself is caught up in a struggle of universal greatness with an atheistic power already more proficient in areas of vital importance. Within our cities great universities stir and plan to meet the demand. They search for talented young men and women not only as students but as members of their faculties. A deep urgency born of love of country will fire the hearts of our graduates. From our schools they will go, and we want them to go. Holy Mother Church wants them to go. Yet with anxious heart she watches them, for it is a calling fraught not only with challenge but with danger. Of the challenge we will speak later. For a few moments let us assess the danger. When we have recognized the danger we must plan to equip our student to understand it and to meet it.

From the time of the Renaissance science disengaged itself from the role of faith, and from the day of Descartes divorced itself from philosophy as well, arrogating to the natural sciences and to the scientific method of analysis, hypothesis, experiment and verification the only valid pathway to knowledge.

Every science in turn declared its independence, its self-sufficiency and, pursued by men alien to the wisdom of philosophy proclaimed itself ultimate and final in its explanation of phenomena. Carried further and further along this path by a long chain of positivist thinkers from Hobbes, Comte, Leibniz, Spinoza, Darwin, Marx, Engels, LaPlace, Bohr, to Einstein and Weyl of our own day, science grew increasingly self-assured, enclosed and authoritative. Absorbed by the power of its method and able by its method to attain only that which is matter, science acknowledged itself Materialist. Its ideal marked out its domain and its domain can be nothing else than the external world, namely the world of bodies including man. It is in fact only external observation, the grouping of external facts and events, that admits of experiments universally verified and capable of being checked. The internal psychic fact, as such, is something incapable of being checked; and all that was not quantitative was regarded as a psychic state. Thus from its very structure and the ideal it pursues, science is linked to matter and in the Republic of Science the boundaries are matter, beyond that is nothing or at least the unknowable. (As with the ancient sailors of Columbus—beyond the sea was a drop off into the void.) All things were explained by matter; and science in this assumed the role of philosopher; for as Prof. Albert Dondeyn of the University of Louvain wrote: "Materialism is philosophical when as the ultimate and definitive explanation of all things, the primacy is given to matter, this being regarded as the substratum the very stuff and ultimate foundation of all beings and of all manifestations of existence. In materialism, matter and reality are synonymous." (*God, Man and the Universe*, p. 4.)

Thus by a continuing chain of thinkers Materialism is regarded as the philosophy of the future, its prestige deriving from its close link with modern science. The alliance has been remarkably successful. Rules and laws are everywhere laid bare. Nature surrenders her secrets to the searching, probing disciples of science. If we examine this fact in the light of the competence of various sciences, we ascertain the mystic hierarchy of this new world. If all that is not quantitative is reducible to psychic phenomena alone, then Mathematical intelligibility is the supremely valid objective.

Exact science, to the degree that it approaches the ideal, assumes the form of mathematical physics. Modern Science bends in homage toward Modern Physics. "The sciences of life," as Father Dondeyn remarks, "in proportion as they transcend the stage of morphological description turn to Biochemistry. Psychology in order to be scientific became behaviourist, confining itself as far as possible to the study of outward behaviour. Sociology becomes positive and static. In short, the higher becomes reduced to the lower, and the process of reduction by analysis becomes the ideal of all ex-

planation. The structure of mathematical physics dominates the whole and summons the lesser sciences to its following." John Van Neumann in his essay called the Mathematician contained in the book, "The Works of the Mind," heralds this rule of mathematics over the lesser sciences with something akin to pity. Herman Weyl, in "Philosophy of Mathematics and the Natural Sciences," endeavours to carry his analysis to the border of life and intimately relate it to Biology. Birkoff in the ultimate apotheosis of this science examines the mathematics of Art and a mathematical equation of Aesthetics, in the final leap of wings held on by wax soars to a mathematical analysis of Ethics.

It is but eighty-five years since Tyndall said that science alone was competent to deal with all man's major problems, but thirty years since Bertrand Russell, contemplating the scientific answers, said that:

> "Only on the firm foundation of unyielding despair can the soul's habitation be safely built. Man is the product of causes which had no prevision of the end they were achieving that his origin, his growth, his hopes, and fears, his loves and beliefs are but the outcome of an accidental collection of atoms; that no fire, no heroism, no intensity of thought and feeling can preserve an individual beyond the grave; that all the labours of the ages, all the devotion, all the inspiration, all the noonday brightness of human genius are destined to extinction in the vast death of the solar system, that the whole temple of Man's achievement must inevitably be buried beneath the debris of a universe in ruins,—all these things, if not quite beyond dispute, are yet so nearly certain, that no philosophy which rejects them can hope to stand." (Russell: *History of Western Philosophy.*)

Only twenty-one years, since Alfred Ayres in his *Language, Truth and Logic*, rejected metaphysics as a cognitive science and declared the role of philosophy to analyze and interpret not real things but the logic of science. In fact, those who sought higher meaning in metaphysics, it was said, should be psychoanalyzed. And this analysis was indeed undertaken. It is true that the extreme position outlined above has been modified by some of science's leading spokesmen such as Eddington and Jean. Confronted with those final stages of science's search in which the very instruments of measurement no longer protect the thing to be measured, and thus deny experimental verification of hypothesis and bound by the limitation of science as its approach to reality, many fine scientific minds have spoken again of the validity of other paths of knowing. Thus, Eddington tells of Mathematics as revealing as much of reality as if knowing a phone number we could claim to know the telephone subscriber completely. And Herman Weyl, in his *Philosophy of Mathematics and the Natural Sciences*, indicates at several points the need of philosophical analysis.

> "Science has become self-conscious and comparatively humble," writes J. Sullivan in his "Limitation of Science." We are no longer taught that the scientific method of approach is the only valid method of acquiring knowledge about reality. Eminent men of science are insisting with what seems a strange enthusiasm on the fact that science gives us but a partial knowledge of reality and that we are no longer required to regard as illusory everything that science finds itself able to ignore. For the universe of science, if accepted as the final reality, made of man an entirely accidental by-product of a huge, mindless, purposeless, mathematical machine."

One of the misfortunes of our educational institutes is that minor professors and text books elaborate as dogmatic, accepted principles of science, theories long since qualified by the very masters who first proposed them.

It is toward this world and into it that we are asked to train our bright young minds, to encourage them toward it, although for many who have gone before it has caused the shipwreck of their faith. The danger lies before us.

Shall we discourage our young scholars from their place in the scientific world? Shall we warn them against the great secular institutes despite the fact that many must rely upon scholarships applicable only to those universities. Shall we tell them to be content to gain a working knowledge of their field in order to accept a lucrative employment but to abstain from the less empirical realms of theory and research. Instinctively we know that none of these attitudes bespeak a solution. To do so would require the scholar to abandon his science and his vocation, to give up to the Devil the things which belong to the children of God. For the Christian, the danger of desertion of the world is not less evil than the danger which confronts him in it. Jacques Maritain, who has grappled with the devils of our age so heroically defines the problem:

> "The Christian body has at such a time as ours two opposite dangers that it needs avoid; the danger of seeking sanctity only in the desert, and the danger of forgetting the need of the desert for sanctity; the danger of enclosing in the cloister of the interior life and of private virtue the heroism it ought to share among mankind, and the danger of conceiving this heroism, when it overflows into social life and endeavours to transform it in the same manner as its materialist opponents according to a purely external standard which has not the same sources as heroism of other kinds. It has its source in the heart of God scourged and turned to scorn and crucified outside the city gate.
>
> It is time for Christian sanctity again as in the centuries of the Middle Ages to put its hand to the things of earth, but with a consciousness that its strength and majesty are from elsewhere and of another order." (Maritain: *Freedom in the Modern World.* pp. 142-145.)

What must we do? What is our duty to our young scholars as we form them in scientific discipline?

First we must communicate to them a sense of their vocation as scholars to the life of the mind. At every stage of their training from the day we open to them the first page of an Algebra or General Science Book and through the succeeding years, we must explain the true scientific method, teach them to respect its intrinsic dignity and to honor its wondrous achievements. Yet, we must not fail to clarify its limits and its true place within the framework of human knowledge. Of its grandeur we must speak,—for it reveals the world; we must speak of its poverty, for in comparison with other valid avenues of knowledge, it suffers the feebleness of its earthly vision. We must instill in them a

compassion for it; for like the Prodigal Son who left his father's house and fared well, indeed—as with every person or thing which says to God, "I will not serve,"—science grinds at the husks of its banquets and writhes in the shadow of Nagasaki and Hiroshima.

We must trace for our students the role of Christian philosophy and of theology in their intellectual life and stress the work of the dedicated Catholic Scholar to search out the last finding of valid science and bring it to his philosophy by which both may be enhanced. We must say to them again, again and yet again—"True science is not contrary to your Faith. There exists a valid rational method of attaining truth called philosophy which can meet and deal with scientific argument." In all this perhaps our great ally will be the virtues of the scientific method itself, with its intrinsic devotion to truth, and its dispassionate search for the real, which may ultimately lead it back to the feet of Truth itself.

From the depths of our heart we must impart to them a love of wisdom, a *philo-sophia,* a hunger to possess knowledge, but not to be possessed by it. Our students must be taught to honor the life of the mind and to pursue it with an almost fanatical dedication. We must exemplify and teach the virtues and mental disciplines of the scholar of Christ such as outlined by Father Sertillanges in his classic work on "The Intellectual Life."

*Courage,* the courage of the weary and dry heart and aching mind will be needed for the tasks are demanding and unrewarding and harsh. For the work before the scholar is apostolic and redemptive.

I have chosen these qualities of set purpose for they form not only the mind but the man, not only the scholar, but the apostle, not only the lover of abstract truth, but the lover of souls and of Christ. For our world cries out for such scholars to whom it would give its secrets before they are wrested from her by that dark power of evil who even now by the strange ascetism of the flesh torments nature with its searching mind. Communism is the master science—the judgement upon our betrayal of truth.

For science, so proud, so autonomous, now bends in chains in the Siberia of its own making. Once it thought itself held fast by the Church, who would use its skills to raise great temples to Christ,—now it is slave to materialism and to its highest expression in Atheistic Communism. Bound now to the purposes of State, it groans in an enchainment which shakes the world, even as it clatters at the stars.

> "No matter how repugnant the Communist Philosophy is to us, we must recognize the fact that those who subscribe to it are true believers. And this, rather than the military or economic power of the Communist empire, is the major source of its strength and its insatiable drive toward world domination."

Such were the thoughts of Vice President Nixon a few days after his visit from Mr. Anastas Mikoyan. In addressing the Alumni of Fordham University, he went on to describe the kind of man who chains the world:

> "In Mr. Mikoyan we saw a man small in physical stature, but a man of iron determination, fanatical dedication, and superb mental discipline. The soft, the flabby, the naive, the lazy will not win in a struggle with men like this. It is not enough that our cause is just. We must have men who are worthy of that cause." (Vice-President Nixon: "The New York Times," Wednesday, January 28, 1959.)

Perhaps it is already too late. Perhaps we have delayed too long and the kiss of our betrayal now clings to the crucified body of Truth from which life has been driven. Perhaps our way back to His feet lies not at all in science but in the darkness of martyrdom such as now covers the hill of Calvary of the tormented people of Russia, China, Poland, Czechoslovakia, Hungary, Tibet and the other enslaved lands.

Sustained by Divine Grace, the Catholic Scholar sets out to do the work given him by the Eternal Father, to dedicate his talent and life to the truths of this world, but beyond that to TRUTH ITSELF. In the light of Him who is truth, he will weigh in the balance all partial fields of knowledge. Beyond all these he will seek Wisdom.

> "Wisdom cries in the streets; she lifts her voice at the crossroads; she preaches at the entry of noisy places, she makes herself heard at the gates of the city: how long, ye ignorant, will ye love your ignorance? Turn . . . and I will shed my spirit upon you . . . I hold out my hand and no one hearkens. (Proverbs, 1:20-24.)

And he will know that beyond all earthly wisdom is that Eternal Wisdom which he is called to taste and share, a wisdom known only to those who seek it and find it in Him Who gives it most at that moment when He is poor and naked and crucified. It is of interest to note that Augustine and Thomas speak of Wisdom as the most elevated gift of the Holy Spirit to man and assign as its expression the beatitudes of the Peace Makers. In contrast to those who serve science alone and become the minions of materialism, spawning as it does the divisions and hatreds of our time, the man of wisdom is a man of peace. His eyes fixed upon the Eternal hills and the vision of the Crucified, his art and skill are directed to the care of the temporal needs of man, but his wisdom heals their souls and brings them peace. Served by such men, the Church will not fear and, over the turmoil of this earth, contemplating the end of the ages when knowledge will be destroyed and Wisdom reign, she will chant her song, in the words of Gertrude von Le Fort:

And your voice speaks:

But when once the Great End of all mysteries shall begin,

When the Hidden One shall blaze forth in terrible storms of unfettered love,

When His home-call shall rend the wasted desire of His creation shall shout for joy,

When the bodies of the stars burst into flame and out of their ashes light shall rise delivered,

When the heavy dykes of matter break and open all the sluices of the invisible,

*(Continued on Page 106)*

# A Note to an Old Professor

• **By Robert T. Hance, Ph.D.,** *(University of Pennsylvania)*
DEPARTMENT OF BIOLOGY, OUR LADY OF CINCINNATI COLLEGE

*Doctor Hance, an experienced teacher himself, addresses a note to one of his former professors.*

*Few realize the full extent of a good teacher's influence.*

●

When I was 22, by paper work of which my mind is now a perfect blank, I became a graduate student duly committed to your guidance. Today it seems more important than any other one thing connected with those years that I have no clear recollection of course requirements, course names, course credits, grades, and all of the other items of university bookkeeping so dear and important to the efficient men and women who head our schools of higher education.

The proof of the academic pudding, to them, lies in satisfactory travel along a regimented route of numbered courses each carrying its quota of credits—the system's medium of exchange for the time spent. No one can be admitted to "the rights and privileges" of a degree without first acquiring the specified "number" of credits. Such credits are perhaps a guarantee of a reasonable knowledge of the mechanics of the field of study but are no warranty of the individual's ingenuity in their application. Too often, however, this learning of what has been done overshadows the interest in what might be done through the use of the old "know how" in new ways. Too often it is forgotten that the only real fun in learning is the aid it gives to pioneering.

However, the student and the teacher alike must yield unto the Caesars that which they believe is theirs but after paying such token tribute the form can be forgotten for the intensions. Little can be accomplished at graduate level that will insure continued pioneering unless the student is allowed a great deal of personal freedom of trial and error. Should this freedom be lost the learner will be forced to miss a lot of fun by an environment shaped through an academic dogma that had lost its connection with human understanding.

Under your guidance, to my joy, I was allowed to find out for myself, to follow my own notions to their denouement, to spin yarns out of whole cloth or out of no cloth at all, which often, in self defense, drove me to weave a pattern of more solid substance. I never felt alone or unguided for you were always ready to talk, if not to lecture, to me.

I have had a fair time to see what makes the training of students effective and I have long hoped that I was transmitting in part that which made so many of my early years unforgettable. Still many of the things that contributed to the atmosphere that made those days what they still are to me, are hardy and stand rough transplanting with good results anywhere.

Your open door was always an invitation to conversation that never seemed unnecessary to me but which I now know took time you perhaps should not have spared me. I cannot now pretend to regret this early thoughtlessness that blocked full realization of my own capacity as a time-waster for your well filled but apparently never hurried days. At least this tendency was another thing I was permitted to learn for myself and then only when I was on the receiving end. You always listened amiably year after year and that too, I believe, is happy teaching.

Whenever I developed sufficient energy to write you a letter I always expected an instant answer and was often disappointed. But answers did come by return mail when such would bring comfort to an upset individual and upon one occasion the answer was brought some hundreds of miles in person.

For a long time I have been looking for a reasonable explanation for what appears to me to be the inadequacies of my generation to live up to the best examples of past academic behavior. Right or wrong I am beginning to believe that one fault is tied up with a widespread failure to understand the possibilities of what we call efficiency. Man cannot function with the eternal predictability of machines and ample allowance must be made for the human factor in the training of a human being. Goose-stepping cannot help but break the spirit in the end because there is no fun in it and never can be.

Bertram Russell seems to have had much the same thing in mind when he closed an article on the function of a teacher, by writing, "it is important that some should continue to realize the limitations of what can be done by organization. Every system must allow loopholes and exceptions; for if it does not it will in the end crush all that is best in man."

Perhaps as we grow older in experience we shall learn to by-pass the apparent logic and appeal of a diagrammatic organization, for a system seemingly lacking in logic. The sole virtue of such a system may be in the satisfactory results obtained in producing human beings skilled in applying old knowledge and in discovering new ways to increase the joy of living.

You once told me that it was suggested that you should not waste so much time on the "damned" student. Apparently you felt that it was not necessary that they should stay damned for these students are now scattered over a lot of territory and, to the best of my knowledge, are without exception continuing in the productive enthusiasm of their early promise. This could not have happened had these students been hedged about with the deadening inflexibilities of paper dicta. I think these students found out that it was fun to find out.

*(Continued on Page 108)*

# The Transatlantic Telephone Cable

• **By H. Austin Byron**
SUPERVISOR—CUSTOMER INFORMATION, THE BELL TELEPHONE COMPANY OF PENNSYLVANIA

*"We are towing the British Isles to America," jested the crew of the* GREAT EASTERN *while laying the 1865 transatlantic telegraph cable.*

*In 1956, America and Europe were linked by a transatlantic telephone cable, and the century old joke became almost literally true.*

Just eighty-three years ago, March 8, 1876, Alexander Graham Bell picked up his new invention which he called the telephone and talked to his associate, Thomas A. Watson, in another room about twenty feet away. This incident was historic in that it was the first time that speech had ever been converted into electrical impulses and transmitted over a pair of wires.

Eighty years later another historic incident took place. On September 25, 1956, a telephone connection between two points, New York City and London, England, 3,000 miles apart, was established for the first time over a new scientific development in the field of overseas communications — THE TRANSATLANTIC TELEPHONE CABLE.

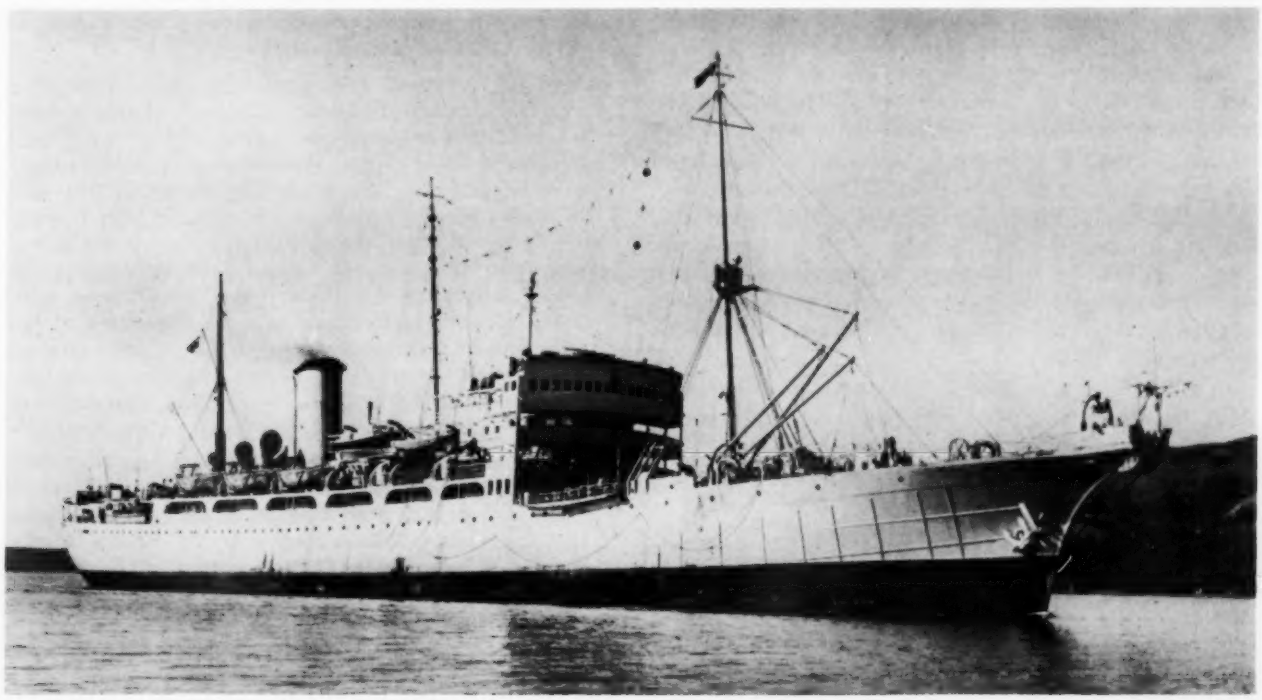
The transatlantic telephone cable was made possible by an agreement between the American Telephone and Telegraph Company, the British Post Office (which operates Great Britain's telephone system), and the Canadian Overseas Tele-communications Corporation. The responsibility for the installation, operation, and maintenance of this $42,000,000 investment in overseas communications is shared by these organizations and each of the three nations involved have made major contributions to the success of the project.

Historically, electrical overseas communications began with the installation of the first transatlantic telegraph cable by Cyrus Field in 1858. Today 22 such cables are in operation.

In the early 1900's, radio entered the field of transatlantic communications and in 1927 radiotelephone service became a reality. Today, more than 200 direct radio routes radiate from this country to all parts of the world, making it possible for us to interconnect, one with the other, some 95% of all the world's telephones.

Since it has been possible for sometime, therefore, to talk across the ocean by radiotelephone, you may be wondering why a transatlantic telephone cable was needed. There are several reasons.

In spite of the tremendous improvements that have been made over the years in overseas radiotelephone service, it still has several limitations. To begin with,



CABLE LAYING SHIP — MONARCH

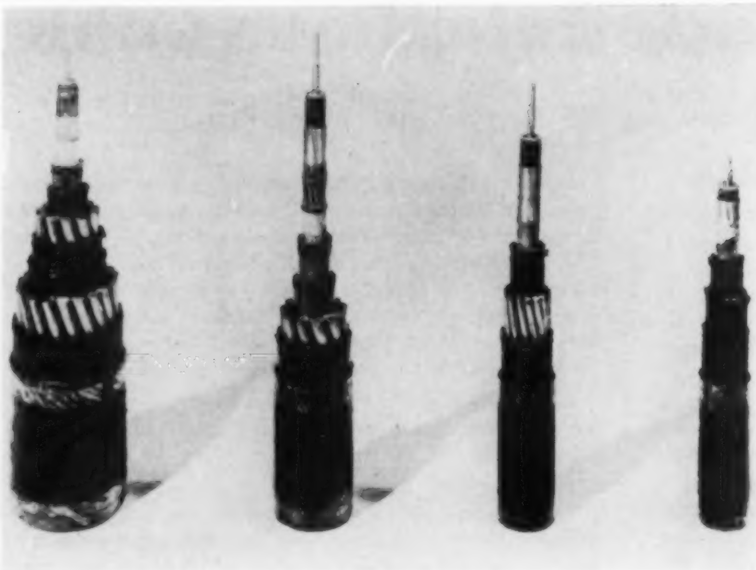


FIGURE 1.

the crowded radio spectrum restricts the number of voice channels which can be provided. Then, too, magnetic storms over the North Atlantic frequently impair the transmission of radio waves, causing fading voice signals, static and sometimes complete failure. By contrast, the new transatlantic cable will not be affected by these atmospheric disturbances, thus insuring a reliable system of transatlantic calling.

Another reason for the cable is that today more people want to talk back and forth across the Atlantic Ocean than ever before and a steady growth is anticipated in the number of these calls. Two months after the cable was opened for service, transatlantic calling increased 50 per cent. Today, its circuits are in the high usage category, handling on an average more than 30,000 transatlantic telephone calls each month.

Looking ahead a bit, we may some day be watching clear, live telecasts from overseas. Although the present cable cannot carry television—its band width is only 144 kilocycles—which is about 1/20 of the band width required for television—enough experience has been gained from its development to indicate that eventually there may be an overseas cable that will carry television.

Figure 1 shows samples of the transatlantic telephone cable. There are four different sizes because the cable varies in size according to the depth of the water. For example, the largest cable size is about two and one-half inches in over-all diameter and weighs 10 pounds per foot. This size is used in shallow water where for obvious reasons the greatest protection is needed. As we approach deeper water, the cable decreases in size until we come to the smallest size, which is only about an inch and a quarter in diameter. This smallest size makes up about 75 per cent of the cable and in some places along its route lies as much as 2½ miles below the surface of the Atlantic.

The cable consists of a single copper wire running through a copper tube. Since both the wire and the tube have the same axis, the cable is called "coaxial." But it is a very special coaxial cable. Three copper tapes are wrapped around the center wire. Then a thick layer of polyethylene, a plastic with high dielectric properties, fills the space between the center wire and the tube which surrounds it. Copper tapes are wrapped around this outer conductor, including a special type of copper tape which protects the cable from the gnawing teredo worm. Around this are successively cotton tape, a layer of jute, 24 steel armor wires, a wrapping of jute to prevent corrosion of the armor wires, and finally a heavy outside wrapping of jute for overall protection.

As many as 36 simultaneous conversations can be transmitted through the copper tube without one conversation becoming confused with another. The same copper tube also provides the electrical pathways for the equipment necessary for the cable's effective operation.

In 1858, as mentioned earlier, Cyrus Field, an American financier, succeeded in placing the first transatlantic cable between Ireland and Newfoundland. It carried only telegraph messages, however, as have all overseas cables until this most recent achievement. The reason, of course, was that the electrical transmission of speech over long distances presents many highly technical problems. Among these one of the most formidable is the problem of so amplifying the electrical impulses carrying the voice to its destination that it will be clearly audible to the called party.

For an underseas telephone cable to be successful, therefore, demanded above all else a highly special type of amplifier—a device that would not only seize a weakened voice signal, strengthen it a million times and then send it on toward its destination but one that would also become a part of the cable so that it could pass easily through the ship's cable laying gear in a continuous operation. It needed also an amplifier so rugged that it could withstand sea pressures of 6,500 pounds per square inch and that could operate at low power in near freezing temperatures over 2,000 fathoms deep in the waters of the North Atlantic. More than this, it needed an amplifier so perfect that it could operate continuously and flawlessly for many years.

The Western Electric Company—the manufacturing and supply organization of the Bell System—ultimately produced just such an amplifier in an incredibly clean plant at Hillside, New Jersey. Incredibly clean because here was a building that was specifically designed for cleanliness—a building where the air, purified by 330 tons of air-conditioning equipment, was ten times as pure as the outside air. The temperature within the building was never permitted to vary more than 2 degrees from 75 degrees Fahrenheit while the relative humidity was held to a maximum of 40%.

All of the work done in this building was done behind glass walls. Before entering these glass-walled areas, each employee put on a special orlon cap and uniform—even special shoes. Each time before entering, hands were washed and shoes cleaned by special vacuum cleaners.

Why all this emphasis on cleanliness? Because here was being performed a task without precedent in all communications history—the manufacturing of an amplifying device so precise in its design and construction that much of the actual work had to be done with binocular microscopes and a speck of dust might some day cost a quarter of a million dollars—the estimated cost of raising and repairing the cable.

The amplifier, as finally developed, is a flexible cylinder eight feet long and one and three-quarter inches in diameter. Each amplifier contains sixty major parts, including a crystal filter in which the maximum permissible change is 0.0005 per cent.

To insure flexibility and durability, the component parts of the amplifier are mounted in a series of seventeen interlocking lucite cylinders. Over these are two layers of steel rings to help withstand ocean pressures—then an overall eight foot tube of pure copper. The entire unit, however, including the tapering ends and leads which fit the amplifier into the cable, is about eighty feet long. Each one took 60 weeks to manufacture and cost approximately $70,000. Spaced some 37 miles apart, there are 51 of these amplifiers in the west-to-east section of the cable and another 51 in the east-to-west section.

Each amplifier contains three vacuum tubes which means that today 306 of these tubes and some 6,000 other electrical components are functioning flawlessly on the bottom of the ocean.

Strange as it may seem, the design of the vacuum tubes used in the amplifiers is today nearly twenty years old, the reason being that it was necessary to life test them for durability and performance before they could be installed on the bottom of the ocean where each one is expected to give at least 20 years trouble-free service. An undertaking of such magnitude required reliable equipment—the proven rather than the unproven. So vacuum tubes of a type which had been on test and operating continuously since 1940 in the Bell Telephone Laboratories, the research organization of the Bell System, were chosen to do the job.

This type of tube operates in one direction, that is, it will only amplify voices coming down a one-way street, thus requiring two cables, one in each direction. Although the west to east cable was completed in the summer of 1955, it was not until 1956, when the east to west portion was completed, that the circuit could be used in both directions.

The leakage allowance in each amplifier is three grams of water in twenty years. That is the equivalent of one drop of water every eight months. However, built into each amplifier is a desiccator unit that keeps the total humidity inside the repeater under ten per cent.

The question is sometimes asked why were not transistors—that amazing new electronic device, also developed by the Bell Telephone Laboratories, used in the amplifiers instead of vacuum tubes—particularly since the transistor has no plate, no grid, no cathode, no filament and no glass envelope; in fact, nothing to break or burn out. The answer here is that the transistor was then much too new; there was not enough experience then available with its performance to take a chance.

An unusual testing device keeps a constant watch on the performance and condition of these amplifiers. Each amplifier transmits an electronic signal which shows how it is aging and which provides a means of locating the amplifier if it should ever break down. The cable is under continuous test, so that if service is interrupted, a quick "roll call" of the amplifiers from the test station locates the trouble.

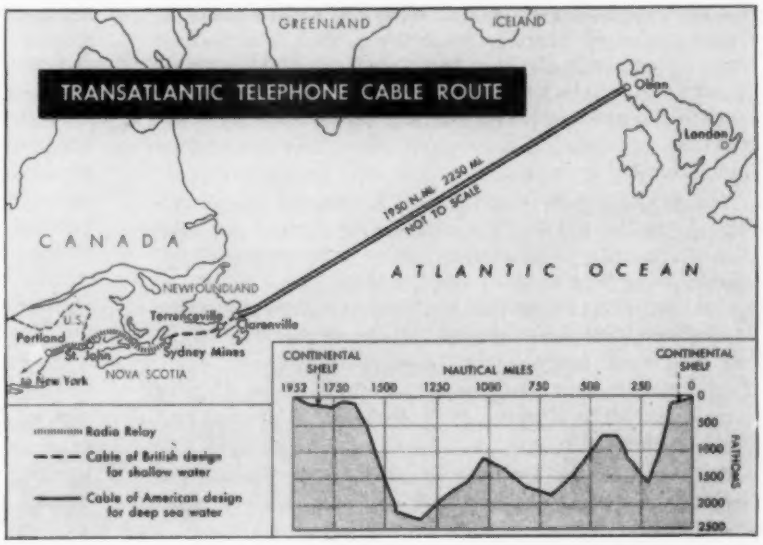
Figure 2 shows the route the cable follows. A call from any point in our country is routed over the usual telephone pathways to Portland, Maine. From there it travels by radio relay to Sydney Mines, Nova Scotia, then by shallow water cable across the Cabot Straits to Terrenceville, Newfoundland and finally to Clarenville, Newfoundland. There the call starts its journey across the Atlantic, a distance of 2,250 miles, to Oban, Scotland where it is sent on to London, England over regular telephone lines.

The transatlantic cable is actually 2,372 miles long because of the shelves and valleys on the ocean floor.

Having installed the west-to-east section of the cable in 1955, the cable laying ship—Monarch (Page 83)—in 1956 began the final leg of its journey by paying out the east-to-west section of the cable. As it slowly made its way toward Clarenville in Newfoundland, its

*(Continued on Page 112)*

FIGURE 2.



# Mathematical Societies in the United States

• By Sister M. Stephanie Sloyan, Ph.D., *(The Catholic University of America)*
GEORGIAN COURT COLLEGE, LAKEWOOD, NEW JERSEY

*Up-to-date teaching methods, knowledge of new trends, and information useful in guiding students interested in careers in mathematics can be gained by membership in a mathematical society.*

*You will find this history of American mathematical societies most informative.*

●

People who are interested in similar things have always grouped together to form clubs or societies to promote their common interests and mathematicians are no exception to this rule. There is a long history of the European academy and of the scientific society, but this paper will discuss American societies only, and of those just such as are concerned directly with the study and teaching of mathematics. Of these, three are outstanding for the length of time of their existence, the assistance they have given to their members, and for their publications.

The first of these groups, the American Mathematical Society, began in New York under the name of the New York Mathematical Society. Ralph Bates, in *Scientific Societies in the United States*, says, "It was fitting that the first steps to form a national mathematical society should be taken in New York, the nation's greatest city. On November 24, 1888, six members of the department of mathematics at Columbia founded a society to meet monthly. Professor J. H. Van Amringe, later dean of Columbia College, served as its first president. T. S. Fiske was another of the moving spirits of the new group."[1] The group expanded beyond the original six to include anyone interested in mathematics who lived in or near New York. Its object was to encourage and maintain an active interest in mathematical science. Starting in October, 1891, the Society brought out the *Bulletin of the New York Mathematical Society*, "A Historical and Critical Review of Mathematical Science." T. S. Fiske and Harold Jacoby were the first editors. There were three volumes published under this title.

The Society grew rapidly and in 1894 its name was changed to the American Mathematical Society to better describe its now national character. The first summer meeting was held in the Polytechnic Institute in Brooklyn on August 14 and 15, 1894, and the *Bulletin of the New York Mathematical Society* became the *Bulletin of the American Mathematical Society* in October, 1894. Early members of the Society, besides those already mentioned, were Emory McClintock, M. I. Pupin, and C. P. Steinmetz.

On December 28, 1894, Doctor Emory McClintock addressed the newly named and growing society with these words:

> While the society is not directly concerned in carrying the study of higher mathematics among the young, its indirect influence in that direction has undoubtedly been felt and must be felt increasingly as time goes on.
>
> It is believed that even already the organization, the meetings, and the publications of the Society have, by the effect of members in association, perceptibly strengthened the tone of the mathematics departments in many institutions of learning.[2]

The second society to be formed was the Mathematical Association of America, and this has an interesting history. During the first ten years of the twentieth century many local mathematics clubs existed, usually consisting of professors and students holding meetings rather like a seminar. Many state teachers' associations had mathematical sections and the most active of these were in the Middle West. The American Federation of the Mathematical and Natural Sciences was founded in 1907, consisting of many associations of teachers of mathematics and the sciences.[3] (A few of the groups that were affiliated were the Association of Teachers of Mathematics of the Middle States and Maryland, New York State Science Teachers Association, the Central Association of Science and Mathematics Teachers, and the New England Association of Chemistry Teachers.)

From these beginnings sprang the Mathematical Association of America. The *American Mathematical Monthly* had been started in 1894 to serve the needs of college teachers of mathematics, and H. E. Slaught, representing the Board of Editors of the *Monthly*, called a meeting of interested persons on the campus of Ohio State University. One hundred four persons attended. At this first formation meeting of the Mathematical Association of America, following the business session, Professor L. C. Karpinski of the University of Michigan gave an illustrated address on "The Story of Algebra".[4] E. R. Hedrick was elected first president, and other charter members were E. V. Huntington, G. A. Miller, L. E. Dickson, Oswald Veblen, R. C. Archibald, Florian Cajori and E. H. Moore.[5] The chief difference between the newly formed society and the already existing American Mathematical Society was that the Mathematical Association aimed at the advancement of the teaching side of mathematics, whereas emphasis had formerly been placed on research. Many teachers belonged to both societies, and already formed mathematical sections in Western states joined with the Mathematical Association. The Association undertook to publish the *Monthly* and later, the Slaught Memorial Papers and the Carus monographs.

In February 1916 was published *A Tentative Platform of the Association*:

> The chief motive is that of service to the whole body of teachers of mathematics in American col-

*(Continued on Page 104)*

# What Does Industry Expect of Technically Trained Graduates?

• By Francis T. Brennan
SMITH, KLINE AND FRENCH PHARMACEUTICAL COMPANY

*While the author discusses the training and qualities necessary for research in industrial biology, he outlines the basic qualities for success in research in any field. The information in this paper should be made available to science-minded high school students.*

*This paper was presented at the Pennsylvania Catholic Round Table of Science at Immaculata College, Immaculata, Pa., April 11, 1959.*

●

Not too many years have passed since college biology majors, upon graduation, were more or less, restricted to the choice of two major careers, viz., teaching or medicine. Opportunities for employment outside the realm of these two excellent professions were, to say the least, meager.

Commencing with the marvelous discovery of the sulfa drugs, penicillin and other antibiotics, and extending through to the new world of experimentation made possible by the electron tube and radioisotopes, with the invaluable contributions simultaneously advanced for improvement of methods in analytical, organic, physical and other phases of chemical effort, the science of biology has seen a veritable renaissance and has been separated into many specialized fields, each offering an interesting and satisfying career for the student.

Prior to the above-mentioned era, most biological research was done in academic institutions. It soon became apparent to industry, which was producing numerous chemicals, medicines and other basic needs, that much time could be saved by initiating its own research facilities. And so it is today that both industry and governmental agencies, like the schools themselves, are spending millions of dollars in the various channels of biological research. It is with these thoughts in mind and with our experience in industrial biology that we shall attempt to describe, in some small way, the training and qualities which are sought in the selection of biology graduates for research in the pharmaceutical industry.

I thought it reasonable to examine the title of my talk. "What Does Industry Expect of Technically Trained Graduates?" from the standpoint of two particular instances *when* industry expects something from the technically trained graduate. Therefore, I took the liberty to divide the title into two sub-headings, each of which is extremely important to a prospective employer. These headings are: *What Does Industry Look for in Hiring a Recent Graduate?* and *What Sort of Training and Qualities Will Help to Insure Success in the Field of Biological Research?*

First—Let us examine the former heading:

### What Does Industry Look for in Hiring A Recent Graduate?

Selection of a recent graduate with a technical background is, of course, not very different from the choice of a student who has come from the arts, business or another field of training. Essentially, the individual has to "sell" himself in a personal interview which is backed up with records or transcripts acquired during the school years.

In industry, responsibility for interviewing and evaluating a prospective employee is shared usually by a representative of the personnel department, a research department head or assistant department head, and a supervisory scientist or scientists who might be in need of the applicant then or in the future.

It may not be apparent to the graduate that these sessions, superficial and informal though they may appear to be, are extremely important in the selection of a candidate for employment. Credentials bearing scholastic achievements carry a lot of weight, but there are other qualities which interest an employer. He might be trying to sense such subtle traits as enthusiasm, congeniality, poise or manners.

I have taken the liberty to list four of the applicant's more important qualities which are surveyed during a typical interview. They are: *Personal Appearance, Speech, Scholarship* and *Outside Interests.*

Personal appearance is no criterion of scientific aptitude but it does reflect generally what kind of a laboratory area he will be inclined to keep. Somewhere, years ago, the scientist was typed as a rather shabby individual. He was one of an absent-minded lot, too preoccupied to care much about himself or his surroundings. That myth, I'm happy to say, and I'm sure all here will agree, has been exploded. Modern science thrives on neatness and order and these qualities are reflected in her inhabitants. Teamwork is such a necessity today that even if the individual himself has no regard for personal appearance, he is at least cognizant that a reasonable amount of tidiness is due to his fellow workers who have to mingle with him.

Speech during the conversation should be natural. A conscientious effort to impress with one's vocabulary is not too important at this time. More emphasis should be put on ease of delivery, correct usage and confidence in communicating with your interviewer. Let him guide the conversation for his time is limited and he will ask you pertinent questions.

Scholarship, in this case, is a passive list of the applicant's credentials which the prospective employer analyzes, observing courses pursued, strong and weak points compiled among acquired grades and final place in the graduating class.

Outside interests indirectly reflect a great deal about an individual's personality. Participation in many types of activity tends to present a more balanced person. It also gives the employer an insight as to how he is apt to get along with people.

We come now to the second heading:

### What Sort of Training and Qualities Will Help to Insure Success in the Field of Biological Research?

Training and qualities which will help to insure success in the field of biological research might be divided into three categories: *Technical Aids, Developed Personal Traits,* and *Moral Judgement.*

It is not intended here to review courses in the biology curriculum which are thought to be most helpful for a career in industrial biology. All subjects are important, and I doubt if there is a great deal of difference in the basic curricula of most of the schools. I would like to emphasize here some training which might not be included in any particular course but which would be helpful for the overall preparation of the student.

#### Technical Aids

The college biology-graduate, I'm sure, has digested enough chemistry to give him a comfortable familiarity with most chemical situations that he will encounter in a biological laboratory. It would, however, be to his benefit if he had paid particular attention to the fundamentals of Biochemistry and perhaps had thought a little more about a few of the techniques and standard values which seemed so hard to master in a course in clinical chemistry. It is perhaps safe to say that most industrial biology is essentially geared, through various species, to the eventual application to man, and, of course, the more we know about normal man chemically and physically, the easier it will be to apply our findings.

Any chemical instrumentation involved, and the same is true with instrumentation associated with biological work, can be taught quickly to the average person with some background in the basic theories concerned. Chances are that the make of a particular instrument may not be the same as that used in school, but the modification or difference will not hinder rapid accommodation for the operator.

The tools of biological experimentation are primarily those described in all textbooks of physiology. Older methods have given way to more sensitive techniques made possible by electronic devices. I think it is safe to say that a smattering of electronics would be very useful to one contemplating a career in biology. Electronic counters, nerve stimulators, electro/encephalographs and electro/manometers are among the growing list of instruments currently utilized in biological research. Some electronic know-how would be of considerable use particularly for anyone contemplating work in the cardiovascular or psychopharmacology area.

Among what I consider to be one of the more important technical aids is experience in handling animals. The more species a person can handle safely, and with confidence, the more valuable he becomes. One cannot accumulate data with animals he is afraid to touch. If a variety of laboratory species are not available because of cost, lack of space or personnel, it might at least be advisable to obtain and show several of the available films depicting the proper *care* and *handling* of laboratory animals. Even a few snapshots or brochures illustrating correct maintenance, for a particular animal might be useful. It is not even ridiculous to know what types of feed is recommended for our laboratory friends.

It is essential in industry, as perhaps in college, *to keep a neat and accurate workbook.* Industry requires that all data be entered in ink daily in a bound notebook, signed and countersigned by the immediate supervisor. This policy not only facilitates rapid rechecks by the company at any time but the U. S. Patent Office will not recognize experiments as valid unless they are entered in this manner. Many industrial legal battles have reverted back to the original notebook. I personally know of a case involving one of the well known sulfa drugs. The company in question won a three million dollar law suit because it could prove from notebooks that it had synthesized the compound three months before its competitor.

Good report writing is another important habit which must be cultivated. Technical reports are devoid of flowery language. Data involving an experiment must be clearly presented, concise and usually with a summary. In most cases short sentences are preferred to long ones.

It may sound ridiculous but occasionally it takes almost as much time to properly write up an experiment than it does to do the actual test. The experience is not wasted, however, for if the time comes when certain data are worthy of publication, meticulous moments spent carefully clarifying experiments in numerous reports, will be valuable to insure proper terminology and form for submission to the critical eye of a publisher.

Good, clear writing becomes important for the presentation of research at scientific meetings. In most instances very little time is allotted at these sessions and one must be extremely concise. It may be at such a meeting that you will be asked to "cover" other papers for the scientists who are not attending. Again, your coverage must be adequate, your notes fairly complete and your report reasonably descriptive of at least the highlights. Not all can attend every scientific session and such coverage these days is essential. Because the biologist deals with living things, it is not expected that his margin of experimental error will be as small as that enjoyed by the chemist. As we know, there can be a good deal of variation in a seemingly homogenous animal colony. For this reason

he has to be most cautious both about the selection of animals for a test, and also about surrounding his conclusions or results with certain reservations. By employing two important tools, viz., experimental design and statistics, actually experimental design is a part of statistics, he has been able to at least cope with the problem. With experimental design he chooses his test animals according to charts which insure unbiased randomization and the experiment is carried out as nearly as possible without extraneous interference or prejudice. Theoretically, any change from control values should show the pure effect of the treatment to the other test animals.

When presenting animal data it is sometimes necessary to be prepared to state a difference between a treated group of animals and those untreated (controls). Is this effect significant, you are asked? It is only with statistical evidence that you can relax the inquisitors and mathematically compare a difference in effects from that which you might get purely by chance.

It may be useful and extremely time saving to know how few animals can be used to get desired results with a reasonable amount of accuracy. Why test a large number when a few carefully chosen ones will suffice? Here again statistics will be of some use. I am not advocating that each student become a statistician, but merely recommend that even a small insight into the purpose and value of statistics, would be most helpful in industrial biology.

### Developed Personal Traits

As the new employee becomes more familiar with the duties he is expected to carry out, he is observed for qualities that develop which will be an aid in evaluating his progress. I think it would be safe to say it takes at least a year before one can begin to access the actual capabilities of a new scientist in industrial research. During this time, and even during subsequent years, some of the following points are considered when examining his progress.

1. *Interest.* Does he consider his work interesting and stimulating? Does he have a natural scientific curiosity? Does he merely go through the motions in an experiment or is he at all times concerned about its progress and success? Of course, it may not sometimes be the employee's fault that dissatisfaction arises. An erroneous or misrepresentative description of the job may have been given at the onset. This, however, is rarely the case. Most trained people at this point consider their work to be interesting and rewarding and go about it with enthusiasm.

2. *Perseverance.* Perhaps the most important quality of a good scientist is Perseverance. Research work is serious business and it is essential that the operator is conscientious at all times about executing the exact design of a particular test. Even under the most carefully controlled conditions, things go wrong, experiments do not turn out as expected and human patience is put to the test. Only experience tempers the frustrations of disappointed research. As we know, even the most undesirable results, if done properly, are valuable in that they might at least enlighten others that this work has been done, or might guide future investigators to the initially desired goal.

   In our business it is disheartening to work in the laboratory for two or three years on a prospective therapeutic aid only to have it rejected by the clinitian as an undesirable drug. It is at times like this that the true quality of perseverance is put to the test, and the scientist must pick up his tools and begin searching again.

   Nearly all scientific advances come as the result of an heroic quantity of pure hard work. There is no short cut—no easy way. There is no way of avoiding the *repetitious* or the *routine*. Only one who has unselfishly extended himself with devoted effort can reap the rewards, the inner satisfaction and pride of accomplishment that come from even the smallest contribution which we might be privileged to make to progress.

3. *Quality and Quantity of Work.* In industry the scientist is paid to do research work. He is not necessarily paid to put out a product. He may be trying to put out a product but to actually accomplish this involves more factors than time would allow me to describe. It is hoped that a product might result from his conscientious effort; therefore, he is expected to do a reasonable quantity, and we hope, quality of carefully directed scientific work. In most cases he is given a project or projects to pursue during a prescribed length of time. It is the current practice for most industrial firms to give to each scientist some elective time (about 20%) for scientific pursuits of his own choosing. Some ideas resulting from this "free" time have contributed much to science and to the companies which allowed it.

4. *Cooperation.* The modern research scientist is not an isolated atmosphere where he alone pursues his problems. More than ever before modern research demands active communication and cooperation with others of the same interests. He must get along with people. Successful personal contact is of paramount importance for the success of existing research efforts. He must be prepared to discuss his results, aims and needs with those who are under him and with those to whom he is responsible. If a member of a research project team, he must discuss his work with others and offer advice where his experience can be useful. It would be difficult to minimize this quality of communications from an industrial standpoint.

   A company nowadays is almost as concerned about you getting along with people as it is with your technical training or know-how. I have seen months, even years, spent in an attempt to fill a particular position. Maybe twenty scientists of equal technical ability will be screened before the one who

*(Continued on Page 110)*

# Plea for the Use of Reason

• By Sister M. Stanislaus, I.H.M., Ph.D., *(Catholic University)*
ASSISTANT PROFESSOR OF BIOLOGY, MARYGROVE COLLEGE, DETROIT, MICHIGAN

*Some suggestions for developing acumen in science students.*

●

Last fall Dr. Margaret Griffing of Ethyl Corporation, Detroit, spoke to the science majors here at Marygrove College. In the interim between then and now I have been mulling over her ideas; and, in the mulling, it has occurred to me that "the millenium" might dawn sooner than we dream if we science teachers would only take to heart Dr. Griffing's indictment, the sense of which was: MANY MEN AND WOMEN DO NOT "ACHIEVE" IN SCIENTIFIC RESEARCH BECAUSE THEY DO NOT KNOW HOW TO THINK CLEARLY, AND/OR BECAUSE THEY DO NOT KNOW HOW TO WRITE DOWN CLEARLY WHAT THEY HAVE FERRETED OUT. This, we all know, is a current national dirge, but since mere lamenting is never constructive, what can be done to avert such charges in the future?

Serious reflection shows that there are means available and that they are ample and varied. Perhaps our best means would be to concentrate on developing in our students both insight and clear-thinking, together with the appropriate expression of both. And how better can we develop the first of our goals—penetrating and cogent thinking—than by letting them see in us the effectiveness of this power?

Let them see, to begin with, the power of something so seemingly simple as terms clearly defined and meaningfully traced to their derivations. Even the least scientifically inclined student can be taught to appreciate the economy of words which exact terms make possible. He can learn, too, that mastery of a few root prefixes and suffixes can save him frequent trips to the dictionary. Many of us, at least occasionally, use *nominal* definitions. "A cell is the unit of structure and function of all plants and animals", for example. Incontrovertible though this may be, one cannot form a clear concept of a cell on the basis of this definition alone. A further point: the *form* of our definitions. We should be careful to adhere to the fundamental rule that each term be properly classified in a "genus" and that the genus be always a noun. We should be precise in the "distinctions" of definitions also. This exactitude requires painstaking effort on our part, for many science textbooks do not provide us with definitions which are satisfactory. The exactitude, however, is worth the effort, for the failure to define terms clearly has made many a discussion end in confusion.

But we have only started to teach when we have defined our terms. It is the superstructure of our presentation which shows discernment. Perhaps some of us have adhered a little too literally to the textbooks we use, instead of trying to sift and measure and weigh a chapter or a unit, to determine its principal ideas, as well as the hierarchy and relationships among them. Here is an interesting though surely not an original assignment to drive home to students key ideas and their relationships, which should be, but often are not evident in their textbooks: Ask the students to read a chapter through carefully; then list in column form the main topics as they occur in the book. If the students are underclassmen, evaluate the organization for them, rearrange the topics, if necessary, in a column parallel to the first, and justify the rearrangement. If they are upperclassmen, ask them to do the evaluating and reorganizing, if they deem it necessary. Even upperclassmen will fail miserably—to the point of damning and reorganizing a perfectly fine text—but they gain power with correction, suggestion, and experience. It is a quite wholesome if disillusioning experience, too, for students to discover that textbooks are not infallible, and that they are merely some of the many tools in the learning process. This is, however, an essential realization for mature men and women, but one to which we shall fail to bring them, unless we ourselves are constantly analyzing and weighing and organizing the subject matter we present.

Clear concepts and fine logic on our part may sharpen our students' minds, but, *per se*, they will not inspire them; nor will homilies on the value of science leave them any less cold or bored. It is our insight and enthusiasm which will be enkindling.

Do we ever pause to share our insights—our realization, for instance, of the prodigality of sperm and seed, of the perfection of each tiny chloroplast and chromosome, of the breath-taking beauty of a ciliate, a diatom, of the miracle of fertilization and development on any level? Do we, as persons, give evidence of the enrichment which flows from pondering the awesome phenomena of nature? No one of us can take refuge in our being pressed to cover the assigned material, for one well-timed word, one phrase, a single utterance can reveal our depth of insight and appreciation, and in teaching, as in friendship, "deep calls to deep."

Not only can we stir our students by our own clear thought and insight; we can do more than this to bring potential to fruition by demanding of them in various ways the exercise of their own great powers.

In the first place, we can avoid treating them as parakeets by not putting all the answers in their mouths. This is important in dealing with the average or slow above-average student. It is especially important for both gifted and less gifted students in laboratory situations, for no word of ours can ever compensate them for the satisfying experience of thinking through and executing a project by themselves.

*(Continued on Page 109)*

# Science is Fun at the Buhl Planetarium

• By Hamilton Lyon
DIRECTOR OF POPULAR SCIENCE PROGRAMS, BUHL PLANETARIUM, PITTSBURGH, PA.

*The Buhl Planetarium and Institute of Popular Science offers many invaluable services to students and teachers of the Pittsburgh area.*

*Teachers should be familiar with museums and institutions which can help make their teaching more effective. Are you making full use of the resources in your locality?*

Yes, science is fun at the Planetarium. It's fun for the fifth and sixth grader who shrieks with delight as the hair on the head of "Mr. Sparks," the gentleman at our electrostatic generator, stands on end or when one of his classmates is stung on the knuckles from the charge delivered by one of our Aides. The elementary student stands in awe as our one million volt Oudin Coil roars into action to produce artificial bolts of lightning and the crash of thunder. It's fun to watch the "Big Bear," "Orion the Hunter," and "Leo the Lion" appear in person in the sky in our Star Theater or see the "Dog Star" do a flip flop.

It's fun for the junior high school student who is fascinated by the demonstrations in our Little Theater of Science as he watches the effects of ultra violet light or the effect of the photoelectric cell. They are intensely interested in the mystery of the Foucault Pendulum. They marvel at the graphic display of sunspots at our Siderostat Telescope in the People's Observatory and the weather demonstrations presented in our Star Theater. They are thrilled with the trip through space in our imaginary "Rocket Ship" to outer space. "Oh's and Ah's" greet the beautiful sky lines that fill the perimeter of our imaginary sky in the History Show, the Geography Show and the Latin Show.

It's fun for the senior and junior high school student to visit our galleries and observe the handiwork of his fellow students in geography, history or Latin. It's more fun to be a winner in one of these exhibits and earn the right to wear the key presented to the winning exhibitors. It's fun on Prize Night for a winner to bring his family to share his glory.

It's a tremendous experience to visit the Hall of the Universe and see the world's finest display of educational visual aids produced under ultra violet light. Here is an opportunity to experience a new concept of the universe and to learn, perhaps for the first time, the magnitude of the celestial bodies, the limitlessness of space, the measurement of time in terms of light years, and the beauty of the Northern Lights.

It's even fun during the Christmas holidays for junior and senior high school students to attend the School Science Congress and discuss with fellow students problems in scientific research—problems which are current and that have aroused the interest and curiosity of today's young scientists. It's fun to go home wearing the School Science Congress key.

It's fun to build a Science Fair exhibit and present it for competition in the School Science Fair. It's a great way to study science, to learn and to earn at the same time. The Science Fair winner may win an award worth from $25.00 to $75.00 in silver dollars or a valuable piece of equipment. For the seniors there is the possibility of scholarship aid at one of the local colleges or a valuable Summer Work scholarship. The greatest thrill of the winner's young life is the Prize Night Ceremony. With his teacher, his family and friends, and the leaders of local industry, he is presented with the Science Fair key and his winnings. The Fair is fun for about 25,000 other students and teachers who visit the Fair annually to marvel at the ingenuity and skill of their contemporaries and to push the buttons and watch the marvels of science unveil.

It's fun for thousands of students from the entire

*(Continued on Page 107)*

"SCIENCE IS FUN!" these Canadian Boy Scouts discover in a recent visit to Buhl Planetarium and Institute of Popular Science, Pittsburgh. The Scouts are participating in an electron discharge demonstration at the Van de Graaff generator. The Van de Graaff is just one of many science exhibits and demonstration that the Planetarium utilizes to prove that science *is* fun!

# Smoke Abatement in Pittsburgh

• By Antoinette Perrotto
SETON HILL COLLEGE, GREENSBURG, PA.

*"The air around us is continuously exposed to both natural and artificial contamination. Under most circumstances air pollution is amenable to control. A knowledge of the composition of pollutants, of the catalytic substances present, of the reactions which occur, and of the shifting equilibria which are reached under varying conditions are all necessary in developing methods to counteract the menace of smoke and pollutants."— From* ENGINEERS' JOINT COUNCIL STATEMENT ON AIR POLLUTION CONTROL.

*Miss Perrotto is a senior at Seton Hill College.*

●

### History of Smoke Abatement in Pittsburgh

The problem of smoke and air pollution in Pittsburgh is almost as old as the city itself. The following quotation from General Presley Neville, Burgess of Pittsburgh to George Stevenson, president of council, written on June 10, 1804 has reference to smoke control. "The general dissatisfaction which prevails, the frequent complaints which are exhibited, in consequence of the coal-smoke from our buildings in the borough, particularly from Smithies and Blacksmith shops, compel me to address you on this occasion. I should be extremely sorry to be in any way the means of subjecting any of our fellow citizens to unnecessary or useless expense, but in this instance not only the comfort, health and in some measure the consequence of the place, but the peace and harmony of the inhabitants depend upon the study of a measure to be adopted to remedy this nuisance."[1]

In 1869 Pittsburgh passed its first public ordinance to control smoke. It stated that "no bituminous coal or wood shall be used in the engine or locomotive employed in conducting trains upon any railroad."[2] Public backing to enforce it was lacking, however, and this ordinance was not effective. Even at this early date, civic leaders were aware that public opinion is necessary for enforcement of these regulations. No one man can force a smoke prevention program upon a city. In dealing with municipal plants or large industries, only public opinion can help. The Allegheny Conference on Community Development was set up during World War II to guide public opinion along legislation such as smoke control.[3]

The year 1912 marked the founding of the Smoke and Dust Abatement Bureau to help in the establishment of legislation against smoke and dust in the Pittsburgh area. This league, which included such agencies as the Allegheny County Medical Society, the Civic Club of Allegheny County, Carnegie Institute of Technology, the Chamber of Commerce and the University of Pittsburgh proposed as a preventive smoke measure the "smoke-consumer." *The Gazette Times* of Pittsburgh reported it is an "iron affair built according to the size of the furnace doors and perforated with holes on the inside which allows excess air to keep smoke down in the fore until the flames entirely consume it."[4]

The Mellon Institute Report of 1913 led to the first effective ordinance in 1914. This report stated the smoke was costing Pittsburgh $10,000,000 a year.[5]

On May 14, 1914, the *Pittsburgh Post* reported that J. W. Henderson, chief of the Bureau of Smoke Regulation of the Department of Public Health of the City of Pittsburgh, was experimenting with a so-called "French Plan" tried in Lyons, France. The plan called for pouring oils on the rivers to reduce fogs. Mr. Henderson predicted optimistically that cities such as Chicago, Boston, and St. Louis would soon be investigating Pittsburgh's clean skies. He pointed out that of 3,000 smoke stacks in Pittsburgh, 1,118 were operating clean and 872 could be operating clean.[6]

In the first nine months of 1915, Pittsburgh had 100 smoky days—81 were of light smoke and 19 were of dense smoke. It is very encouraging compared with the record of 1913 in which the city had 314 smoky days with 55 days of dense smoke.[7] Around 1920, the Smoke Abatement Bureau was set up under Dr. H. B. Meller who was responsible for much research on reducing the cost of smoke elimination.[8]

The *New York Times* on October 21, 1927 stated that Pittsburgh reduced smoke 70% since its smoke control went into effect. The householders, however, were the principal violators; while industry was being curbed, residences were not. Average deposits of smoke in Pittsburgh were 2.87 tons per square mile compared to 3.37 tons per square mile in London. The *New York Times* cited that 10 years previously the figure for Pittsburgh was 39.92 tons per square mile. "If this keeps up, New York may yet have to take lessons from Pittsburgh."[9]

In 1938, the City Council abolished the Smoke Abatement Bureau. One thousand tons of soot, 10 tons of tar and 261 tons of iron oxide fell on a square mile of Pittsburgh in this year alone. In the winter months, fogs from the Ohio Valley mingled with Pittsburgh's smoky air to become smog. By noon, on a smoggy day, streets were blackened, planes grounded, street lights and auto headlights were turned on and in use.[10]

With no control at all, the smoke conditions became unbearable. A series of disagreeable days in February, 1941, caused such a wave of newspaper agitation and public feeling that once more steps were taken to end the problem. Much of this renewed interest was caused by the St. Louis experiment in smoke control. St.

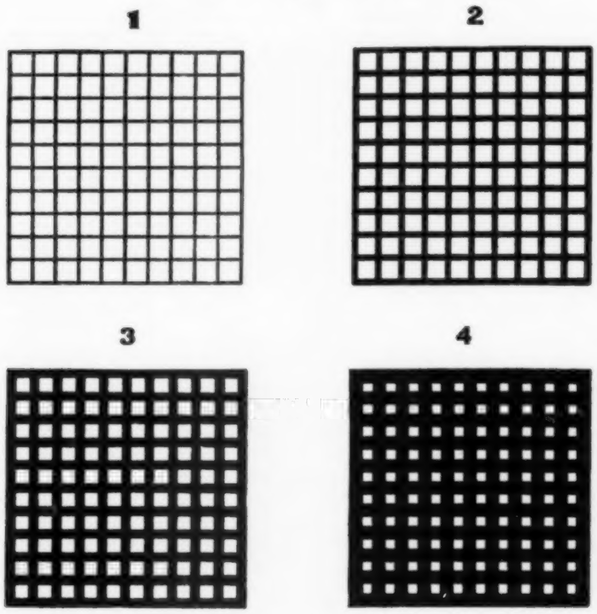
Louis was experiencing its first winter under strict smoke-control laws that reduced the hours of smoke 71% compared to the previous year. Public dissatisfaction with the smoke situation in Pittsburgh culminated in an ordinance that went into effect October 1, 1941, but two months later World War II and its immediate need for steel tabled the ordinance.

In view of the area's industrial and mining might, the problem was to draft a smoke abatement ordinance that would be fair to industry as well as the public, but yet achieve good results. The man more responsible than any other person for Pittsburgh's achievements in this area was Professor Sumner B. Ely, Director of the Pittsburgh Bureau of Smoke Prevention until 1957.[11] Through his efforts, the 1947 ordinance became the first fully effective law.

Briefly, here is a digest of the Pittsburgh Smoke Ordinance in effect. It is ordinance Number 344.

1. For the purpose of grading the density of smoke, the Ringlemann Chart, as now published and used by the U. S. Bureau of Mines shall be the standard. Dense smoke, defined as No. 2 Ringlemann, is prohibited. This means that No. 1 and up to No. 2 is permitted at all times by law.

RINGLEMANN CHART




2. Solid fuels of mixtures, if used in hand-fired furnaces, must not contain over 20% volatile matter.
3. Incinerators, tugs, and steamboats come under the general smoke provisions above.
4. A steam locomotive being serviced comes under the general smoke provisions above. A steam locomotive in service shall be permitted to emit dense smoke for a period or periods aggregating one minute in any one hour.
5. The fly ash shall not be emitted in quantity to exceed 0.30 grains per cubic foot of flue gas at a stack temperature of 500° F. and 50% excess air.
6. Cinders, noxious acids, fumes and gases shall not be allowed to escape into the atmosphere as to cause injury, detriment, or become a public nuisance.
7. New installations, either coal, gas or oil, must be approved by the Bureau of Smoke Prevention. The Bureau must make annual inspections of heating equipment. [12]

Allegheny County passed its own smoke control law effective June 1, 1949. The county law differs from its city counterpart in this respect. The city law regulates noxious acids, fumes and gases, while the county law does not. Whereas the county law spells out detailed requirements for types of industrial fuel burning equipment, the city ordinances does not. However, the county's jurisdiction is 12 times as large as the city's and extends over 129 separate political subdivisions.[13] The county law was written primarily on an engineering basis, recognizing steel industry problems; one-seventh of all steel capacity in the United States is located in Allegheny County. As a further nuisance, Allegheny County topography is so rugged and the concentration of industry so great, that other problems were presented to successful smoke abatement.[14]

### The Chemistry of Smoke

Smoke, fogs and clouds are very much alike. Solid and liquid dispersed particles exist in them.[15] Smoke fits in the aerosol category since "aerosols" are applied to particles in suspension in a gaseous medium. Aerosol particles having a diameter less than one micron exhibit the characteristic behavior of smoke. In air pollution studies, aerosols are classified as dusts (formed by the disintegration processes), fumes (solid particles generated by the condensation of solid matter vapors after molten state volitilization) and mists (liquid particles from chemical reactions, condensation of vapors, or liquid disintegration). These aerosols describe the physical properties of the smoke constituents.[16]

Smoke may contain large particles as well as airborne particles in the submicron range. In coal burning operations the larger residual particles are frequently described as fly ash.

It is important to know something about the formation of carbon-containing smoke. The best, but still imperfect insight can be obtained by considering the combustion of natural gas—$CH_4$.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

It is assumed that sufficient oxygen is present. This combustion is more complicated than the expression of a simple chemical equation. The first reaction $CH_4$ undergoes is the formation of free hydrogen atoms possessing more energy than $H_2$ molecules. These hydrogen atoms react with $O_2$ molecules and form $HO_2$ radicals (peroxide radicals). Simultaneously, with the splitting of the $H_2$, organic radicals, the methyl radical $CH_3$, methylene $CH_2$, and methine CH, as well as the dicarbon radical $C_2$ are formed.

Through chain reactions, the $CH_4$ molecule is finally degraded to CO and $H_2$, so-called water gas. With the

# *UNITRON* student microscopes offer

## UNITRON STUDENT AUTO-ILLUMINATION MICROSCOPE, MSA

The UNITRON Student Auto-Illumination Microscope, Model MSA, employs a newly designed stand in which all components and controls are within easy reach. The inclined eyepiece tube allows comfortable posture and may be turned in any optional observing direction to permit two students sitting side by side to share a single instrument. With the built-in illuminating system of the superior low-voltage type, each student is assured of the correct lighting. The transformer is conveniently housed in the microscope base itself where it contributes to the stability of the stand rather than to the clutter of the laboratory table.

Model MSA comes complete with triple revolving nosepiece and three objectives: 4X, 10X, 40X; three eyepieces: 5X, 10X, 15X; coarse focusing with safety stop; fine focusing; condenser and iris diaphragm; filter holder and filter; accessory substage mirror; wooden cabinet and dustcover. Mechanical stage available at extra cost.

In quantities of 25 or more . . . **$94.16** **only $107**

## UNITRON STUDENT MICROSCOPE, MUS

Despite its low cost, UNITRON Model MUS offers features lacking even in much more costly models usually offered for student use. For example, both fine and coarse focusing are provided — not merely a single focusing control; an iris diaphragm to regulate aperture for highest resolution — not merely a disk diaphragm; and a condenser system for optimum illumination.

The optical performance of Model MUS at each of its magnifications is equivalent to that of expensive research models. All mechanical parts are machined to close tolerances and the stand is beautifully finished in black and chrome. Model MUS comes complete with triple revolving nosepiece and three objectives: 5X, 10X, 40X; choice of two eyepieces from: 5X, 10X, 15X; coarse focusing (accessory safety stop available); condenser with iris diaphragm; inclinable stand; planoconcave mirror; wooden cabinet and dustcover. Mechanical stage available at extra cost.

In quantities of 25 or more . . . **$66.66** **only $74**

exception of acetylene, CO and $H_2$ mixed with air exhibit the largest limits of explosion or combustion.[17]

Very complicated reactions takes place if $CH_4$ is burned with insufficient amounts of air. In this instance, smoke in the form of colloidal carbon is produced. It is this carbon caused by improper combustion that must be eliminated.[18]

Coming back to the simple methane decomposition, free radicals are the parent materials for these different kinds of smokes. There are many different possibilities for the polymerization of these radicals.

The methyl radical forms parafin hydrocarbons stopping further polymerization of other radicals. The methylene radical ($CH_2$) gives rise to polymerization of chains and rings with or without a certain amount of bound oxygen. The hydrogen content in these products is too high to form smoke. The methine radical (CH) lends itself more easily to the formation of smoke than $CH_3$ and $CH_2$. A polymerization of the radicals in ring-form also takes place. Graphite is formed at the end of the series.[19]

Unlimited numbers of different carbon smokes can be formed with the high probability that no two smoke particles are completely identical. If one starts from more complicated systems, e.g., napthalene or phenols, an unbelievable multitude of different smokes are formed.

The electron microscope has given welcome insight into particle sizes of different carbon blacks.[20] However, the electron microscope does not tell the whole story. These colloidal carbons exhibit unusual behavior. These concern their wetting properties with water and benzene and hydrophobic materials. Tensile strength, hardness, water and oil absorption, plasticity—all these phenomena show great deviation from the expected behavicr if only the particle size is considered. The surfaces calculated from the size of the spheric particles, as well as the surface chemistry of these smokes play big parts. The surface chemistry is closely connected to the form of the different radicals, straight chain, branched chain or ring polymers, quantity of bound oxygen and bound hydrogen.[21]

Flue gas without smoke is obtained if coal is burned with an excess of oxygen in well designed furnaces. But if this burning is done in poorly designed combustion units, like kitchen stoves, a distillation of the bituminous coal occurs during which phenols and similarly acting substances are formed in addition to the formation of larger amounts of CO.[22] The phenols are inhibitors. They retard many reactions, and show a

very high temperature of self-ignition in mixture with air.

It is known that aromatic compounds, like phenols ignite only at high temperatures because of their low hydrogen content and their ring formation. If more hydrogen is incorporated in these aromatics, as in naphtalene, they are converted into mixed aromatic-hydroaromatic compounds which ignite and burn easily.

Aromatic hydrocarbons burn with a bright flame and produce large amounts of soot. They react very slowly, as in phenols and napthalene, due to their high temperature of ignition and their great stability.[23]

Now the behavior of bituminous coals is related to their chemical composition. In those installations where coal is used to produce heat energy, the formation of aromatic hydrocarbons and their oxidation products, phenols, is a very unpleasant property of bituminous coals. They exhibit soot formation more often than the low temperature and high temperature cokes and the natural anthracites which behave in a manner similar to the artificial coke.

Bituminous coals, therefore, cause trouble because of their aromatic composition. Thus, the chemist and researcher have many problems to overcome in combating this menace to the city.

### Cost of Smoke and Physiological Effect

Few Pittsburghers realized that the smoke problem was more than an annoyance. It was very expensive according to Mr. J. H. Greene, Executive Vice President of Pittsburgh's Chamber of Commerce in 1941. He estimated the cost of smoke to Pittsburgh as $16,000,000 a year.[24] Economic losses reach tremendous heights when cleaning bills and damage to vegetation are considered. The disappearance of valuable compounds to the atmosphere from industrial processes represents another expensive loss. The development of technology for the recovery of air wastes should be explored as a conservation measure. The cost of cleaning the atmosphere is a burden to the industrial community, but the funds expended annually for air-pollution control are estimated to be only $100,000,000 compared to the one and one-half billion dollars of economic loss from all causes.[25]

H. Balman says there is profit in air pollution control just as there is in any activity. He continues that if it is not profitable, smoke control should not be established. Mr. Balman feels too many programs in smoke regulation have failed because of claims that smoke affects health. Smoke as such has never been ascertained by the medical profession to directly or adversely affect health. Smoke Prevention Programs today approach the problems on the realistic basis of regulating a nuisance instead of starting from the early false premise of a health problem.[26]

Yet, Pittsburgh has had the highest constant pneumonia death rate of any community in the world. In analyzing the pneumonia death rate of the city by wards, it becomes clearer that the denser the smoke content of the air the higher is the pneumonia death

rate. During 1933, a depression year of decreased smoke, the pneumonia deaths were 91.8 out of 100,000 people; in 1936, a year of increased production and smoke, the pneumonia death rate was 167.4 out of 100,000 persons in Pittsburgh.[27] It is commonly said that doctors could recognize a diseased Pittsburgher by the blackened condition of his lungs.[28]

Certainly, atmospheric oxidation of $SO_2$ to $SO_3$ and the resulting $H_2SO_4$ mists contribute to haze formation. Olefenic, branched-chained, and cyclic compounds present in gasoline vapors are readily oxidized in the presence of sunlight and oxides of nitrogen to produce gases which are highly irritating to the eyes and cause damage to vegetation. Smokestacks do contain ammonia, sulfuric acid, and nitric acid, formaldehyde, and even the wartime poisonous gases, chlorine and phosgene.[29]

*The Encyclopedia of Chemical Technology* still emphasized that the physiological effects are not definite and more study is needed to correlate health hazards and smoke. Most of the effects from air contaminants in industrial areas are considered to have only nuisance value.

### Means of Eliminating Smoke

Control measures must be designed to relieve the detrimental effects resulting from smoke and air pollutants. Smoke control is only one part of the solution to the total air-pollution problem. First efforts are made toward smoke and fly ash control because these nuisances are visible to average citizens and unnecessary. Further efforts might be made to eliminate all air pollutants. Vapors and gases are examples.[30]

Smog attacks on entire communities can be minimized only by control programs against air contaminants. The famous Donora episode will be long remembered in the pages of the smoke history. During the horrible smoke menace of October 1948, 20 people died and 6,000 became very ill. In addition, 800 animals were killed.[31] The Donora Report to Public Health Services concludes that, "It seems reasonable to state that while no single substance was responsible for the October, 1948 episode the syndrome could have been produced by a combination, or summation of the action of two or more of the contaminants."[32]

In a period of one year a study of particle fall deposits indicated that $SiO_2$, PbO, $Fe_2O_3$, $SO_3$, ZnO, $Al_2O_3$, CaO, MgO, $V_2O_5$, $Cr_2O_3$, $TiO_2$, NiO, CuO, $MoO_3$, $As_2O_3$, were found in at least trace amounts.[33]. Combustion engineers agree that smoke is wasted fuel and reflects inefficiency. A survey showed that 10 pounds of soot are filtered into a Pittsburgh house each month. Therefore, most current smoke and air pollution control programs try to correct the three basic causes of excess smoke: careless operation, improper equipment, and lack of information on correct firing methods.[34]

Earliest attention in American smoke abatement was directed naturally toward belching factory chimneys and equally obnoxious coal burning steam locomotive stacks. They emit more smoke in winter months than in summer. Underfeed stoker equipment and overfire air jets have been found to be effective measures.[35] Overhead fire jets force air into the furnace when it is needed and mix the air with unburned gases. If an excess of air is already present, the jets mix this air with the combustibles.

Homeowners can aid in smoke abatement by learning the technique of proper firing.[36] Proper firing has to do with regulation of furnace drafts and how coal is placed on the fire bed. Spreading the coal over all the burning matter releases the volatiles as well as great quantities of smoke. A good fireman stacks the bituminous coal in a cone in the center or in a sloping heap on one side. Combustion then takes place at the foot of the slope with little smoke resulting.

Also, careful consideration of equipment design can result in a marked reduction of smoke. The burning of bituminous coals produces secondary distillation products which, due to their chemical nature, ignite only at very high temperatures and burn rather slowly. As a result, enough space and reaction time must be supplied. The temperature of this secondary phase of the conversion unit is kept high by radiation from the hot walls of the combustion unit. The secondary and tertiary products are completely burned under formation of flue gas without production of smoke.[37]

Some of the modern "chimney sweeps" chemists have discovered, which are used primarily in industry, include centrifugal collectors, electrostatic precipitators, scrubbing methods, and various filtration methods.

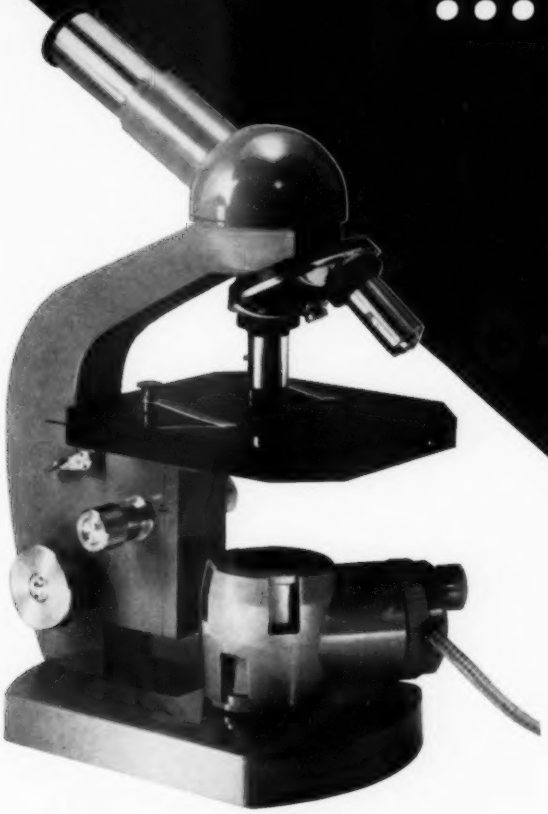
*Centrifugal Collectors:* The high speed of the hot gas flow from many industrial processes is utilized

## *Elgeet* of Rochester... *Presents:*

# ...a new slant

## on Student-Teaching

# microscopes



**Elgeet-OLYMPUS Model S-2**

only **$99.45** in lots of five

list price $110.50 each

Pictured standard model S-2 with double revolving nosepiece with hard-coated parfocal, achromatic interchangeable 10X (N.A. .25) and 40X (N.A. .65) objectives. Built-in revolving aperture disk to control illumination. 10X Huygenian coated lens eyepiece. Choice of concave mirror or interchangeable 20 watt illuminator (Model LSK) as shown.

Write for information on other student-teaching models and complete microscope line.

Science means progress, and to help both teachers and students meet the challenge of a changing world, Elgeet presents a superb new microscope with research instrument features never before offered in student-teaching models!

The inclined eyepiece is typical of the many new features, extending to students the benefits of unsurpassed convenience, ease of operation, and efficiency combined with working comfort, resulting in maximum learning possibilities even over prolonged periods of close concentration.

Rugged and versatile, the Elgeet-Olympus is precision engineered and designed for years of trouble-free service and priced for educators seeking the very best . . . on a budget.

*MAIL COUPON NOW*

Dept. SM-3
Elgeet Optical Co., Inc., Scientific Instrument and Apparatus Div., 838 Smith Street, Rochester 6, New York.

☐ Please send me complete literature on the New Elgeet-Olympus Microscopes.

☐ Please send name of Elgeet Dealer nearest me for free demonstration.

Name ..........................................

Address ..........................................

City .............................. State ...........

*Elgeet* OPTICAL CO., INC. . . . SCIENTIFIC INSTRUMENT AND APPARATUS DIVISION
838 SMITH STREET • ROCHESTER 6, NEW YORK
*"Quality is our watchword . . . Precision Engineering our constant goal"*

to remove solid particles by centrifugation. In removing solids from smoke, the gases are passed at high speed through spiral coils, which whirl the gaseous suspension. The gravitational force thus created draws out heavier solids permitting lighter gases to continue out the stack.[38] These collectors are low in initial cost and simple in construction; they provide dry and continuous discharge of collected matter. Power consumption is low and maintenance requirements are nominal. However, collection efficiencies are definitely limited in removing small particles. The collectors are used to advantage where dust concentrations are high or as the primary stage of a two-stage collection system.[39]

*Electrostatic Precipitators:* The most popularly known smoke and dust collectors utilize an electrostatic attraction which is created artificially. These collectors are the expensive, but highly efficient, electrostatic precipitators.[40] The operation is very interesting. A wire suspended in the smokestack, or several wires arranged in units occupying their own buildings, imparts an electric charge to the smoke particles. Meanwhile, near the wire are metal plates which carry an opposite charge thus attracting the charged particles.

Sometimes the smoke adheres mechanically to the energizing wire. This produces an insulating effect that can be overcome only by increasing the power load. The use of barbed wire has solved this problem. European scientists had learned earlier that the barbed wire points remained clean and provided continuous electrical discharge. With the proper spacing of the barbs, engineers are able to control the discharge throughout the entire precipitator.[41]

The heavy duty electrostatic precipitator is a high voltage device in which particle charging and deposition occur simultaneously. The voltage in this precipitator ranges from 30,000 to 100,000 volts. Primary use of it is in the steel industry.[42].

An ingenious yet simple modification in electrostatic precipitators for home, office, and commercial use was made by Electro-Air Cleaner Co., Inc., McKees Rocks, Pa. It provides for a greater particle collecting surface in a smaller space.[43]

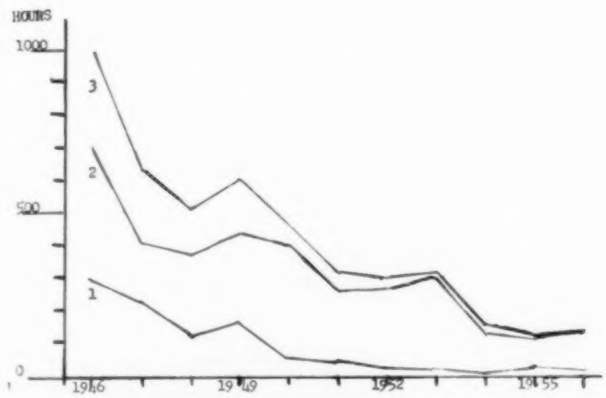
The cost of a single precipitator is $200,000. A rough cost rule is $1.00 to $1.50 for each cubic foot of gas cleaned a minute.[44] Fly ash is effectively eliminated by electrostatic precipitators.[45]

*Filtration Methods:* Bag type filters, which are similar to the vacuum cleaner dust collecting bags, are used widely. Most of this type rely on a fine weave to mechanically trap the dust and smoke particles.[46]

Some filters may be only skeleton structures to support liquids which in turn are the filters. One type has an endless steel mesh belt passing through an oil bath first and subsequently through a portion of the exhaust gas pipe or smokestack. Oil trapped in the mesh is the collector of the dust and smoke particles.

Other filters take advantage of the fact that most small particles have a slight electric charge. These filters then use fabrics charged oppositely. In this way, the filter bag will stop, by electrostatic attraction, smaller particles than could have been collected mechanically by the fabric weave alone.[47]

In *Scrubbing*, the factory's gases and smoke are passed through tanks of water or water spray towers for removal of impurities. The gas flow is dried and subsequently released into the atmosphere. On occasion, the water is chemically treated so that it may form compounds with the smoke and gas content which are retained in the scrubbing solutions.




United States Weather Bureau Observations, Pittsburgh, Pa.
Curves: 1. Heavy smoke
2. Moderate smoke
3. Total smoke

There are many other methods for eliminating air pollution. In the *Impaction Method*, for example, gases are hurled against rods, cylinders or screens which trap particles impacted on them. The *Agglomeration Method* consists of treating the particles chemically, electrically or mechanically to cause many small particles to coagulate into larger particles for easier removal. Adiabatic steam and ethylene glycol are used to promote impaction and agglomeration.[48] The *Settling Method* can be used in unit operations or in other small continuous operations where waste gases are allowed to collect in tanks and stored long enough to permit suspended particles to settle.

*High frequency sound waves* shake soot out of smoke. High intensity sound agglomerates fine particles so that they are readily removed by one of the methods described above.[49]

*Catalysts,* "Oxycat," developed by Chemist Eugene Houdry, takes odors and fumes out of industrial processing plants. This catalyst (platinum alloy) converts the soot and gaseous wastes into harmless but extremely hot $CO_2$. They produce an extra dividend of heat which can be used in the plant's operation.[50]

Also in the line of smoke elimination, the Pittsburgh Consolidation Coal Company built a Disco plant near Imperial, Pa. to turn out smokeless fuel under the name "Disco." In a special continuous process, preheated coal is fed into rotating carbonizers. Inside it is treated to 1000° F. It comes out in the form of Disco. For every ton of coal, 1440 pounds of Disco are produced, together with 3700 cubic feet of gas and 15 gallons of tar.[51]

## Progress In Smoke Abatement

In "Air Pollution Control In Ferrous Industries," G. A. Howell, states that the magnitude and variety of operations in the larger steel plants make air pollution an enormous task. Mr. Howell considers some specific steelmaking operations and what progress is being made in attempts to control atmospheric emissions.

In the study of open hearth dust loadings, there is a large percentage of fume present in stack gases from an oil-fired open-hearth. This is an indication that either an electrostatic precipitator or a high-energy require-

ment wet washer is needed to reduce the solid content of the stack emission.

Blast furnace dusts are removed in three stages. Cyclones remove the large particles; low-energy requirement wet-washers remove the next smaller sizes and electrical precipitators or high energy wet-washers remove the smallest size particles.

Howell concludes by stating that push button control is impossible in the steel industry since each type of facility represents individual problems, with particular units of a type presenting even further problems to solve and overcome.[52]

By 1956, the steel industry completed installation of equipment needed to wash all gas from blast furnaces. Steel companies have improved by-product coke ovens by including close hooding where the coal is introduced, better fitted and carefully sealed doors.[53] Industry spent $250,000,000 to control smoke (which was reduced 88%) since 1946.

The fly ash which industry turns out in quantities of 10 to 15 tons daily is used as a mixing material in cement. It is also used for road materials, insulation, and brick.[54]

## Automobiles

A new problem is presented with growing popularity of automobiles because automobile exhausts pollute the air. Scientists are beginning a new attack on this factor which they believe is a major one in causing air pollution. They are trying to find out why incomplete combustion takes place in the auto engine. Complete combustion should produce $CO_2$, water vapor and energy; partial combustion gives a mixture of $CH_4$, ethylene, nitrogen, hydrogen, acetylene, carbon, and CO, as well as $CO_2$ and water. Some suggested treatments are:

1. Have gases absorbed into liquids which could be discarded. No absorbent seems to be efficient enough.
2. Gases could be adsorbed on activated carbon. The adsorbing agent would have to be replaced too often.
3. Centrifuge gases, i.e., whirl them at high speed till the noxious components are separated and trapped. This is too expensive.
4. Filtration methods, refrigeration, air dilution, and addition of chemical are all impractical.
5. The answer may lie in further oxidation of the gases with the aid of a catalyst. However, there is the possibility here that the lead in gasoline may poison the catalyst.[55]

## The Weather Bureau Report

The degree of progress is shown in part by the records of the U. S. Weather Bureau which takes hourly readings of atmospheric clearness designated as "Smoke Observations." In Pittsburgh, these observations are taken each hour during the day and graded into moderate and heavy smoke by determining the distance certain objects can be seen. Moderate smoke would correspond to No. 2 and No. 3 on a Ringlemann Smoke Chart. Number 1 is allowed at all times. In 1956 there was no heavy Numbers 4 and 5 smoke.[56] It is also heartening to note that in 1956 Pittsburgh had 122 hours of moderate smoke and no hours of heavy smoke.

## Railroads

In the early days of smoke elimination, perhaps the number one problem was the control of smoke released by the steam locomotives. As late as 1945, diesels were practically unknown on the railroads; they were considered too light in weight to give adequate traction. The electric diesel has overcome this difficulty by utilizing the weight of the train and providing motors on car axles. Figures show that diesels are great fuel savers; in addition, their upkeep is low. All railroads in the Pittsburgh area were 100% dieselized by 1956.[57] Pittsburgh has no steam locomotives. The Bureau of Smoke Prevention believes that the diesel was perhaps the greatest factor in eliminating smoke in Pittsburgh. ●

### REFERENCES


1. Story of Pittsburgh (Scrapbook), p. 60.
2. Edward R. Weidlein, "Organizing for Effective Air Pollution Control," *Journal of the Franklin Institute*, CCLXIII, No. 2 (February, 1957), p. 97.
3. *Ibid.*, p. 99.
4. *Gazette Times*, November 24, 1912.
5. *Pittsburgh Post*, July 11, 1914.
6. *Pittsburgh Post*, January 10, 1915.
7. *Ibid.*, December 15, 1915.
8. *Ibid.*, July 11, 1920.
9. *New York Times*, October 21, 1927.
10. "Clearing Pittsburgh's Air," *Newsweek*, XXX (October 13, 1947), p. 22.
11. Frank C. Harper, *Pittsburgh, Forge of the Universe*, (New York, 1957) p. 210.
12. Bureau of Smoke Prevention Ordinance No. 344, Department of Public Health, City of Pittsburgh, 1956.
13. Weidlein, p. 103.
14. G. A. Howell, "Air Pollution in Ferrous Industries," (United States Steel), Presented before the Symposium on Atmospheric Pollution Control for Chemical Industries, (November 11, 1952), pp. 2-3.
15. E. Berl, "Smoke Seen Through the Eyes of a Chemist," (Carnegie Institute of Technology, Pittsburgh, Pa.), June 9, 1943, p. 1.
16. "Smokes and Fumes," *Encyclopedia of Chemical Technology*, XII.
17. Berl, pp. 4-6.
18. S. B. Ely, "Atmospheric Pollution in Pittsburgh," *Proceedings U. S. Technical Conference on Air Pollution*, (1951), p. 432.
19. Berl, p. 7.
20. Howard F. McMurdie, "Application of the Electron Microscope to Air Pollution," *Proceedings U. S. Technical Conference on Air Pollution*, (1951), p. 415.
21. Berl, p. 10.
22. G. R. Mattocks, "Smoke Formation From a Bituminous Coal," *Fuel Society Journal*, V (1954), pp. 15-23.
23. Berl, p. 16.
24. J. H. Greene, "Air Hygiene in Pittsburgh: It Costs Pittsburgh $16,000,000 a Year for Smoke Damage," *Greater Pittsburgh*, XXII (1941), p. 4.
25. Weidlein, p. 102.
26. H. Balman, "Smoke Abatement—How It Started, What It Involves," *American City*, LXVI (November, 1951), p. 119.
27. Meller, "Smoke Abatement in Pittsburgh—Its Progress As Summarized by Mr. Meller," *Greater Pittsburgh*, VIII (1926), p. 1.
28. G. Mann, "Wiping Out the Choking Death," *Science Digest*, XXXV (January, 1954), p. 44.
29. *Ibid.*
30. H. Balman, p. 119.
31. "Unusual Smog Episode of October, 1948 in Donora, Pa.", *U. S. Public Health Bulletin*, No. 306, (1949).
32. Arthur C. Stern and Leonard Greenberg, "Air Pollution—The Status Today," *American Journal of Public Health*, XLI (January, 1951), p. 218.
33. S. B. Ely "Air Pollution in Pittsburgh," *Archives of Industrial Hygiene and Occupational Medicine*, III (January, 1951), p. 45.
34. "Why Cities Fight Smoke," *American City*, LXIV (August, 1949), p. 109.
35. A. C. Monahan, "Solutions to Air Pollution," *Science News Letter*, LVI (October 22, 1949), pp. 266-267.
36. *Ibid.*
37. T. F. Hurley and L. J. Flaws, "The Prevention of Smoke From Heating Boilers," *Journal of the Institute of Heating and Ventilating Engineers*, XXIII (1955), p. 10.
38. David Pursglove, "Modern Chimney Sweeps," *Science News Letter*, LXXIII (March 8, 1958), p. 154.
39. *Encyclopedia of Chemical Technology*.
40. S. E. Specht and R. W. Sickles, "New Uses of Electrostatic Precipitator in Control of Atmospheric Pollution," *Air Repair* IV (1954), p. 317.

41. Pursglove, p. 145.
42. Harry J. White, "Electric Precipitation," *Industrial Engineering Chemistry*, XLVII (1955), p. 933.
43. Pursglove, p. 154.
44. G. J. McManus, "Air Control, Effective But Expensive," *Iron Age*, CLXXVIII (October 25, 1956), p. 70.
45. "Electrostatic Precipitation of Fly Ash," *Mechanical Engineering*, LXXII (1950), p. 873.
46. Pursglove, p. 155.
47. *Ibid.*
48. "Aerosol Build-Up Technique," *Industrial Engineering Chemistry*, XLIII (1951), p. 1338.
49. Hillary W. St. Clair, "Theory and Basic Principles of Sonic Smoke Flocculator," *Proceedings U. S. Technical Conference on Air Pollution.*
50. "Smoke Eliminator, Catalyst Converts Fumes into Odorless Heat," *Life*, XXXIII (September 15, 1952), p. 33.
51. "Smokeless Fuel Will Help Keep the Air of Pittsburgh Clear," *Business Week*, No. 993 (September 11, 1948), p. 22.
52. Howell, pp. 3-15.
53. "More Clean Air Progress in the Pittsburgh Area," *American City*, LXXI (April, 1956), p. 116.
54. H. L. Jacobs, "Fly Ash Disposal," *Sewage and Industrial Wastes*, XXII (1950), p. 1207.
55. David Pursglove, "Search for Clean Air," *Science News Letter*, LXXII (November 30, 1957), p. 346.
56. Bureau of Smoke Prevention Report, 1956, p. 7.
58. Engineers Joint Council Statement, p. 5.

## BIBLIOGRAPHY

"Aerosol Build-Up Technique." *Industrial Engineering Chemistry*, XLIII (1951), 1336-1346.

Balman, H. C. "Smoke Abatement—How It Started, What It Involves." *American City*, LXVI (November, 1951), 119.

Berl, E. "Smoke Seen Through the Eyes of a Chemist." Carnegie Institute of Technology, June 9, 1943.

*Bureau of Smoke Prevention Report of 1956.* Department of Public Health.

"Clearing Pittsburgh's Air." Newsweek, XXX (October 13, 1947), 30.

"Electrostatic Precipitation of Fly Ash." *Mechanical Engineering*, LXXII (1950), 873-880.

Ely, S. B. "Air Pollution in Pittsburgh." *Archives of Industrial Hygiene and Occupational Medicine*, III (January, 1951), 44-47.

Ely, S. B. "Atmospheric Pollution in Pittsburgh." *Proceedings of the U. S. Technical Conference on Air Pollution*, (1951), 431-433.

*Gazette Times*, November 24, 1912.

Greene, J. H. "Air Hygiene in Pittsburgh: It Costs Pittsburgh $16,000,000 a Year for Smoke Damage." *Greater Pittsburgh*, XXII (1941), 4-7.

Harper, F. *Pittsburgh, Forge of the Universe.* New York. Comet Press Books, 1957.

"How Allegheny County Progresses With Smoke Control." *American City*, LXIV (October, 1949), 87.

Howell, G. A. "Air Pollution in the Ferrous Industries." Presented before the Symposium on Atmospheric Pollution Control for Chemical Industries, (November 11, 1952), 1-16.

Hurley, T. F. and Flaws, J. L. "The Prevention of Smoke From Heating Boilers." *Journal of the Institute of Heating and Ventilating Engineers*, XXIII (1955), 1-31.

Jacobs, H. L. "Fly Ash Disposal." *Sewage and Industrial Wastes*, XXII (1950), 1207- 1213.

Pittsburgh, Story of. *Scrapbook of Pittsburgh.*

Pittsburgh Post, July 11, 1914.

Pittsburgh Post, January 10, 1915.

Pittsburgh Post, December 15, 1915.

Pittsburgh Post, July 11, 1920.

Mann, G. "Wiping Out the Choking Death." *Science Digest*, XXXV (January, 1954), 43-47.

Mattocks, G. R. "Smoke Formation From Bituminous Coal." *Fuel Society Journal*, V (1954), 15-23.

McManus, G. J. "Air Control, Effective But Expensive. Pittsburgh Reports Total Smoke Improvement." *Iron Age*, CLXXVIII (October 25, 1956), 70-71.

McMurdie, Howard F. "Application of the Electron Microscope to Air Pollution." *Proceeding of U. S. Technical Conference on Air Pollution*, (1951), 182-183.

Meller. "Smoke Abatement in Pittsburgh—Its Progress As Summarized by Mr. Meller." *Greater Pittsburgh*, VIII (1926), 1-7.

Monahan, A. C. "Solutions to Air Pollution." *Science News Letter*, LVI (October 22, 1949), 266-267.

"More Clean Air Progress in the Pittsburgh Area." *American City*, LXXI (April, 1956), 71.

*New York Times*, October 21, 1927.

Pursglove, David. "Modern Chimney Sweeps." *Science News Letter*, LXXIII (March 8, 1958), 154-155.

Pursglove, David. "Search for Clean Air." *Science News Letter*, LXXII (November 30, 1957), 346.

"Smokes." *Encyclopedia of Chemical Technology*, XII.

"Smoke Eliminator." *Life*, XXXIII (September 15, 1952), 85.

"Smokeless Fuels Will Keep the Air of Pittsburgh Clean." *Business Week* (September 11, 1948), 22.

Specht, S. E. and Sickles, R. W. "New Uses of Electrostatic Precipitation in Control of Atmospheric Pollution." *Air Repair*, IV (1954), 137-140.

Stern, A. C. and Greenberg, L. "Air Pollution—The Status Today." *American Journal of Public Health*, XLI (January, 1951), 27-37.

St. Clair, Hillary. "Theory and Basic Principles of Sonic Smoke Flocculation." *Proceedings of the U. S. Technical Conference on Air Pollution.* 1951, 380-87.

"Unusual Smog Episode of October 1948." *U. S. Public Health Bulletin.* No. 306, (1949).
Weidlein, E. R. "Organizing for Effective Air Pollution Control." *Franklin Institute Journal*, CCLXIII (February, 1957), 97-106.
White, Harry. "Effect of Fly Ash Characteristics on Collector Performance." *Air Repair*, V (1955), 37-50.
White, Harry. "Effect of Fly Ash Characteristics on Collector Performance." XLVII (1955), 932-939.
"Why Cities Fight Smoke." *American City*, LXIV (August, 1949), 109.

★ ★ ★ ★ ★

## Mathematical Societies

*(Continued from Page 86)*

leges. The new organization will not undertake to discuss or to publish papers specially dealing with the details of secondary interest, though it may well undertake to discuss and define questions concerning the preparation of students who enter colleges, particularly with reference to testing in mathematics.[6]

There has always been amity between the two organizations, many names on their membership lists being identical. Even now, the annual meetings held in January, and the summer meetings held in August, of the Association and the Society are held in conjunction with one another. In addition there are sectional meetings of both groups. The Society now numbers about 5700 members, and the Association, about 7300.

On September 1, 1916, Professor T. S. Fiske, ex-president of the American Mathematical Society, offered the felicitations of the older Society to the new Mathematical Association:

> After 25 years of constant but comparatively slow growth, the American Mathematical Society has a membership of less than 800, while the new Association now on the day of its first meeting numbers considerably over 1000.
>
> These two organizations must have intimate and friendly relations for many reasons. In the first place they have a large body of members in common . . . In the second place, they have, to a large extent, a common aim, or more accurately, closely related and mutually helpful aims . . . For my part I am inclined to think that every American mathematician should wish to belong to both organizations.[7]

There is one more large group devoted to the interests of mathematics teachers, this time on the secondary level, and this is the National Council of Teachers of Mathematics. *The Mathematics Teacher*, a journal concerned chiefly with the problems of the secondary mathematics teacher was begun in 1908 by the Association of Mathematics Teachers of the Middle States and Maryland. The National Council of Teachers of Mathematics was organized in the spring of 1920 at a National Education Association meeting in Cleveland, Ohio, and the council was patterned on the National Council of Teachers of English. The first president of the National Council was C. M. Austin, of Oak Park High School, Oak Park, Illinois. The Council took over the publication of *The Mathematics Teacher* and listed its reasons for existence in that organ:

1. To keep the values and interest of mathematics before the educational world. "We prefer that curriculum studies and reforms and adjustments come from teachers of mathematics rather than from educational reformers."

# AO Reports on Teaching with the Microscope

## Measurements through the microscope...or how to clock a speeding protozoan

We don't know who he was or when it happened, but the man who made the first measurement and recorded it, probably became the world's first true scientist. Man has been gathering and recording measurement data ever since... virtually nothing escapes his tape measure. The astronomer uses light-years to measure the infinite reaches of the universe; the microscopist uses microns to measure a universe that recedes into infinite smallness; in between lies a vast army of scientists measuring everything on or beneath the earth... indeed, the earth itself... using every conceivable unit of measurement.

The scientific method requires, essentially, the gathering and recording of data... this can be, in itself, an exciting thing. Students can find this to be particularly true as they use the microscope to measure the "unseeable". We hope the following tips on making measurements through the microscope will give your students a new appreciation of this aspect of the scientific method.

### MEASUREMENTS THROUGH THE MICROSCOPE

### 1. ESTIMATE SPECIMEN SIZE

If the field size provided by the objective—eyepiece combination is known, the size of comparatively large specimens can be estimated simply by determining how much of the field the specimen covers. Approximate field sizes provided by the three standard magnifications are as follows·

100X (10X obj., 10X eyepiece) = 1500 microns
430X (43X obj., 10X eyepiece) = 350 microns
970X (97X obj., 10X eyepiece) = 150 microns

To determine field sizes of other low power objective/eyepiece combinations, simply focus on a millimeter scale using oblique illumination (light directed onto surface of scale to reflect off and up into optical system of microscope). You can convert millimeter readings into the microscopists' standard unit of measurement, the micron. One micron is equal to 1/1000 of a millimeter.

### 2. CROSS-HAIR EYEPIECE

A cross-hair in the eyepiece will mark off the field of view into approximately equal quadrants, thus making it easier to estimate specimen size, particularly if specimen covers less than half the field. Here's how to make a cross-hair disc and insert in eyepiece.

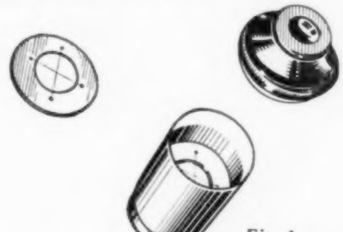


*Fig. 1*

**A.** Select a thin washer of proper diameter (approximately ⅞") to fit inside eyepiece. Use human hair (preferably blonde because it is finest) and model airplane cement to fashion a cross-hair over the washer, see fig. 1.

**B.** Unscrew top lens element from eyepiece. Place washer with cross-hair in eyepiece directly on diaphragm... replace top lens element.

### 3. ESTIMATING SPEED OR MOVEMENTS OF LIVE PROTOZOA, ETC.

Interesting exercises into the realms of relativity and mathematics can be worked out using live protozoa. Observe protozoa under low power and use stop watch to calculate time required for one specimen to traverse entire field or portions of field divided by cross-hair. Microscope magnifies size only, not time. Converting microns per second to the familiar miles per hour results in increased student understanding of the various units of measurement.

### 4. EYEPIECE MICROMETER

Exact measurements can be made by means of a scale, or micrometer disc, placed in the eyepiece. The divisions in the eyepiece micrometer disc have arbitrary length. The apparent length depends upon the total magnification used. Therefore, before the disc can be used to measure a specimen, it must be calibrated for use with each combination of objective and eyepiece against a stage micrometer. A stage micrometer has divisions of true length. The AO Spencer stage micrometer, Catalog Number 400, has a 2mm scale divided into 200 parts... each part measuring .01 mm. Every tenth part on the scale is numbered, see fig. 2. If you want complete information about eyepiece micrometers and stage micrometers just write to: Dept. U237 American Optical Company, Instrument Division, Buffalo 15, New York.

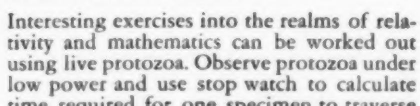



*Fig. 2*

### PROCEDURE

**A.** Unscrew top lens of the eyepiece... insert eyepiece micrometer, *ruled side down* on the diaphragm within the eyepiece. Replace top lens.

**B.** Place stage micrometer on microscope stage...focus sharply with 10X objective. Rotate eyepiece and move stage micrometer until both scales are in juxtaposition along the same axis and both scales are even at one end, see fig. 3. Now count the number of arbitrary divisions of the eyepiece micrometer that fall within a specific true distance on the stage micrometer. In fig. 3,

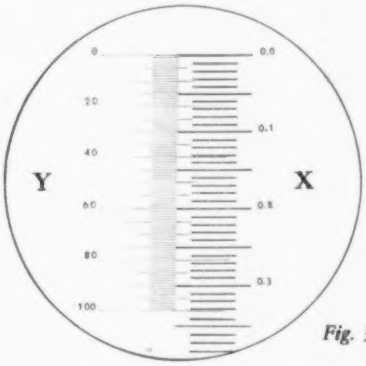



*Fig. 3*

for example, the first 21 divisions of the eyepiece micrometer (Y) fall within 7 divisions of the stage micrometer (X). We can find the calibration constant (C) simply by dividing the true distance (X) by the number of divisions of the eyepiece micrometer (Y); i.e.:

$$C = \frac{X}{Y}$$

$$C = \frac{7(.01)}{21}$$

$$C = .003 \text{ mm; or 3 microns}$$

Now, using this as an example, if a specimen is measured against the eyepiece micrometer scale and found to span, let us say, 10 divisions, we can determine its size by multiplying the number of divisions it spans by 3 microns, i. e. 30 microns.

**NOTE:** The eyepiece micrometer must be calibrated at each magnification. Once calibrated, the constant should be noted and then the eyepiece micrometer need not be recalibrated if those same magnifications (and tube length) are used.

**$25 For Your Experiment.** We will pay $25.00 for each experiment involving either laboratory or stereoscopic microscopes accepted by us for future ads like this one. We're looking for unusual experiments suitable for the high school and junior college level. In the event of similar experiments the one bearing the earliest postmark will be used. The ad containing your experiment will bear your by-line. Write in now!

**American Optical Company**

Instrument Division • Buffalo 15, New York

2. To furnish a medium through which teachers in one part of the country will know what is going on in other parts.
3. To furnish (by the Journal) a medium of expression for teachers.
4. To assist the progressive teacher to be more progressive.

The National Council has expanded tremendously since its beginning in 1920, and has done much to fulfill the aims stated above. On its membership lists are found junior high school teachers, secondary school teachers, and members of teacher training institutions.

More and more national groups are springing up, in addition to all the local sections, but these three associations are probably of the greatest interest to mathematics teachers. ●

**REFERENCES**

1. Bates, Ralph S., *Scientific Societies in the United States*, Second Edition, Columbia University Press, New York, 1959, p. 96.
2. McClintock, Emory. "The Past and Future of the Society," *Bulletin of the American Mathematical Society*, Vol. I, Jan. 1895, p. 91.
3. Bates, *op. cit.*, p. 97.
4. *American Mathematical Monthly*, Vol. XXIII, Jan. 1916, p. 1.
5. Bates, *op. cit.*, p. 98.
6. *American Mathematical Monthly*, Vol. XXIII, Feb. 1916, p. 31.
7. Fiske, T. S., *American Mathematical Monthly*, Vol. XXIII, pp. 296-297.
8. *The Mathematics Teacher*, Vol. XIV, Jan. 1921.

# Science and Wisdom

*(Continued from Page 81)*

When decades of centuries sweep back like eagles, and embattled aeons come home to eternity,
When the vessels of speech shall be shattered, and torrents of the never uttered shall burst forth,
When the loneliest souls are washed up into the light, and see there what they never knew about themselves:
Then will the Revealed One raise my head, and before His sight all my veils will rise in flames,
And I shall lie there like a naked mirror in the presence of all worlds.
And the stars will find in me their praises, and the ages will find in me their eternity, and the souls will find in me their divinity.
And God will recognize in me His love.
And henceforth my head shall wear no other veil than the dazzling light of Him who is my judge.
The world will be lost in this veil of light.
And the veil shall be called mercy, and mercy shall be called infinite.
And the Infinity shall be called blessedness.

Amen. ●

## Science is Fun at Buhl

*(Continued from Page 91)*

Tri-State Area who visit the Planetarium each year to gasp, to laugh and to thrill at the science demonstrations and visit our Sky Shows to see not only the distant stars and planets, but with the magic of our sky line projectors and stage facilities, go back in time to General Forbes at the Point, to the First Christmas, or to the Easter scene and to all points of the compass today. We may journey to the North Pole or the South Pole or the jungles of Africa in our Geography Show. We may travel with Columbus or visit the Mediterranean in our History Show. We will likely go to Rome in our Latin Show and see the grandeur of that ancient city with the star-studded sky of the Mediterranean.

It can be a rewarding and inspiring experience for the teacher whose students are sparked to new interest and new curiosity in the classroom presentations. The student has a new and greater desire to study and learn more about the science of biology, physics or chemistry. The student who enters the School Science Fair and engages in the necessary research and develops the technical skill required to be a winner can be a joy to his teacher and his parents. The honors achieved may result in a whole new future with a scholarship opportunity as the beginning.

And for the senior science student, there is the

School Science Experts Quiz Broadcast sponsored by The Buhl Planetarium, The Pittsburgh Press, Radio Station KDKA and WQED-TV. It's fun to appear on one of the 16 broadcasts and earn the right to compete for scholarship aid at one of our local colleges or universities.

It's fun for hundreds of elementary and junior high school students who attend the Buhl Junior Space Academy in the summer to learn about the mystery of the heavens, to build a telescope or rocket or space ship, and to study the planets. It's fun at the end of the summer to attend the graduation exercises and hear leading scientists in the field of space.

It's been fun for several hundred junior high school students to attend Saturday morning classes at The Buhl Planetarium to build a telescope, study the stars or rocket into space.

Thousands of adults have enjoyed our evening hobby classes. Many have found a new joy in improved photography. They have learned how to take good pictures in color or perhaps learned more about the techniques of the press photographer or the public relations photographer. Many others have enjoyed courses in electronics provided for the amateur radio and television mechanic. Hundreds have come to improve their knowledge of the stars and planets and get more fun out of their telescopes. Many have found it fun to brush up on their mathematics, world geography or nature study. And more recently, people are finding it great fun to travel into space using the magic at our command in the Star Theater.

Yes, Science can be fun for everyone at The Buhl Planetarium and Institute of Popular Science. ●

★ ★ ★ ★ ★

## A Note to an Old Professor

*(Continued from Page 82)*

I have many times been more than a little sorry that I cannot say fluently and directly what I feel but I know that once more you are listening and are as usual making sense out of incoherence.

When I was 22 I began now unremembered courses that put me to work and started me on the way to recognizing that instruction in the letter without its illumination by the spark of the instructor's humanity is apt to be the sterile mouthing of a history that almost certainly and indeed, as I see it, fortunately can never repeat itself. The letter of culture can be a deadly thing but its spirit—the only thing that is worth while in education—receives no academic credit because it is so rarely a part of the curriculum.

When I was 22 I had a good time learning how to work. I like to think that you had a good time with me. ●

## Plea for the Use of Reason

*(Continued from Page 90)*

Secondly, we can prepare assignments, quizzes, and examinations which will involve more than mere fact-gathering and fact-recalling. For the assignment, "Read the first ten pages" we might make a more enlivening substitution. And in place of the test directives, "Name, or list, or label, or enumerate," we might say, "compare, predict, analyze, or make a plan." But assignments and tests are the requirements in learning. Can we not encourage a little supererogation? Once in awhile let us propose a speculative problem to be solved for the sheer joy of solution. Some will disregard the problem with flat indifference, but others will respond with amazingly fine answers. In the laboratory, too, we can give students more opportunity to exercise their creative ability. Their efforts to demonstrate geotropisms may show any phenomenon except the one in point. But, in the long run shall we not have accomplished more if we have taught them to recognize, correct, and profit by mistakes, than if we have dictated every step and helped them at every turn of an experiment?

So far we have been encouraging the development of our students' purely intellectual resources, but our efforts must not stop here. We must train them to communicate intellectual discoveries effectively, especially in writing, and this is a challenge.

Let us meet the challenge to begin with by more care about our own expression, oral or written, which precision students will not fail to note. Grammar, style, and diction should not be the prerogatives of English teachers. Further, let us encourage excellence in writing in our students by providing ample opportunity for writing complete, coherent sentences and paragraphs, and also conscientious correction of their errors of fact and form. The fifth different spelling of penicillin may provide an endurance test, but if we keep our ultimate goal in view we can pass it. A third way to stimulate good writing is to provide our students with specific norms by which they can evaluate their own work. We can, for example, give them typed and unidentified copies of three different grades of work which they as a group have submitted. The copies can be labeled "superior," "good," and "poor," and justification for the ratings be given, or the copies can be simply distributed for the students to examine and grade. This is a procedure which fulfills its purpose easily, for it is an activity in which student interest runs high.

These are, in brief, some of the means at our disposal to bring the student to use his highest and most peculiarly human power—his reason—in science. Despite the means available we shall be tempted to despair if we are too unrealistic. When we have labored to be paragons of clarity and organization, and have tried to produce assignments that will intrigue the most inert, when we have corrected every examination with a microscopic eye—when we have done all this and more and have netted such monstrosities as, "Antibiotics are

people who are against life in general," and "The Egyptians' contribution to biology was their method of IMBOMBING"—only a sense of humor will save us. This gift let us cherish. As teachers we may see only the oysters. Notwithstanding, if we keep diving day by day, directors of research will find the pearls, and we shall know who cultured them. ●

★ ★ ★ ★ ★

## What Does Industry Expect

*(Continued from Page 89)*

displays, according to company thinking, the most potential for congenial cooperation or who will be thought to "fit in" with the group, will be chosen.

5. *Initiative.* If a newly employed scientist generates the expected amount of interest in his job, it is certain that evaluating him for initiative will not be difficult. It will be noticed how much he is capable of "taking over" in the absence of his immediate superior. His recommendations for possible improvement in methods will show that he has imagination and is thinking ahead. His eagerness to do more than just what is expected will be appreciated and noted.

6. *Further Improvement.* Even the most specialized research has unlimited boundaries and one never reaches that static state where we have learned everything that there is to know. A scientist is therefore obliged continuously to improve himself, whenever possible, by further technical courses or training. He is advised to attend pertinent lectures, to read available journals and in general, to be alert for any information which might broaden his current interests or general background.

### Moral Judgement

This category reminds the employee of some of his obligations to himself as well as to his employer. That a scientist be completely honest in examining, evaluating and presenting technical data is self-evident. He realizes that he would be jeopardizing his professional standing if he attempted to give false or misleading experimental data. Dishonesty is about the worst sin possible in research.

Even though the research scientist appears to possess more freedom in his job than that seen in most other professions he too is subject to authority and must obey his line superior. Again, he must not be subject to severe emotions and must be level-headed when recommendations for his work are forwarded.

In all fairness he must realize that he has a good job with good pay in American industry and is morally obliged to put in a good day's work for his employer. ●

# New Books

### Power Unlimited

Pp. VIII + 152. $3.50.

### Tomorrow the Moon

Pp. X + 150. $3.50.

• Both books by ABRAHAM AND REBECCA MARCUS. Prentice-Hall. Englewood Cliffs, N. J. 1959.

These excellent popular science books are written in language that is clear and nontechnical, completely modern in content, and can be recommended to the junior or senior high school student or the adult who wishes to learn something about modern science.

Both authors have many years of classroom experience and the manner in which the subject matter is presented indicates that they are good teachers. Excellent line drawings by Peter Costanza supplement the text and add greatly to the clarity and attractiveness of the books.

*Tomorrow the Moon* is an excellent treatment of Newton's first law, rockets, jet engines, missiles, man-made satellites, and space stations. The authors take great care to explain clearly the basic principles underlaying the operation of space engines, satellites, and other topics.

*Power Unlimited* follows the same basic plan as *Tomorrow the Moon*, but the subject matter is a little more difficult. The young reader who plans to read both books should read *Tomorrow the Moon* first. However, any good high school student will not find it difficult to understand. In content the book goes from water and wind power to fusion and solar power, and in all discussions basic principles are clearly explained.

### Careers and Opportunities in Engineering

• *By* PHILIP POLLACK. E. P. Dutton and Company, Inc. New York. 1958. Pp. XVI + 140. $3.50.

This is an excellent book for the student who is interested in engineering as a career or is seeking information on which to base his choice of a career. It is well written and contains much accurate and up-to-date information.

The history and present status of the engineering profession are briefly but interestingly surveyed. Chapter three on the qualifications and training of engineers is especially good. All the principal fields of engineering are surveyed and the last chapter discusses engineering as a career for women.

This book is highly recommended for high school libraries.

*J. P. M.*

### The ABC of Relativity

• *By* BERTRAND RUSSELL. A Mentor Book, published by The New American Library. New York. Pp. 144. $10.50.

This is a revision of Bertrand Russell's *The A B C of Relativity* originally published in 1925. It has been revised by Felix Pirani, who has added a chapter on the expanding universe.

The book is well written, and by expert use of analogies and examples, it presents an excellent review of the general and special theories of relativity. While it is easy to read, it is still thought provoking and can be highly recommended to all who desire a basic knowledge of relativity. It is nonmathematical in its approach except for a few simple discussions and diagrams which can be easily understood even by the person who normally skips any mathematical discussion that occurs in his reading.

This little book can be recommended as the best popular introduction to the theory of relativity now available.

*J. P. M.*

★ ★ ★ ★ ★

—*Photo by* V. DEER, C.S.Sp.

## Transatlantic Telephone

*(Continued from Page 85)*

crew kept in constant touch with Oban to make sure that all was well as the cable and its amplifiers slipped into place on the ocean floor.

And so it was that on September 25, 1956, the transatlantic telephone cable—perfection under the sea—was officially opened for service.

How successful it has been is best evidenced by the fact that construction work is now underway on a second transatlantic cable, this one between Clarenville, Newfoundland, and Penmarch, France. Owned jointly by the Bell System and the telecommunications agencies of the French and West German governments, this second cable—a duplicate of the one now in service—is scheduled for completion in 1959. When it is completed, 36 more voice pathways in each direction will span the Atlantic.

As the work goes forward on this second cable, it is gratifying to realize that, in these troubled times and even though oceans lie between them, men of good will can still work together for the common good. That this is true was dramatically emphasized at the dedication ceremonies for the first transatlantic telephone cable when representatives of all of the three nations involved in its construction not only emphasized the importance of the cable to future friendship between nations, but eulogized it as a symbol of how nations can work together to better serve their fellow men. ●